**Vol. XXVI. — No. 11.** **November 1949.**

BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[ **621** .337 ]

# Individual axle drive.

## Mechanical systems used on electric locomotives and railcars, with an indication of the results obtained in service on railways of all kinds,

*(Continued*)*

by Adolphe-M. HUG,

Consulting Engineer, of Thalwil, (Zurich) Switzerland.

## SUPPLEMENT. — APPENDIX.

*(Continued)*

## Types of mechanism which have been introduced, or first described, since this survey was commenced in 1947.

N. B. — *This supplement completes, on the one hand, the author's work dated 1932/33 on the Individual axle drive (Commande individuelle des essieux), and on the other hand that published serially in the* Bulletin of the International Railway Congress Association, *Nos. of September, October and December 1947, February, April, July, October and November 1948, January and May 1949.*

*The subject-matter is, therefore, as far as possible complete up to the end of 1948.*

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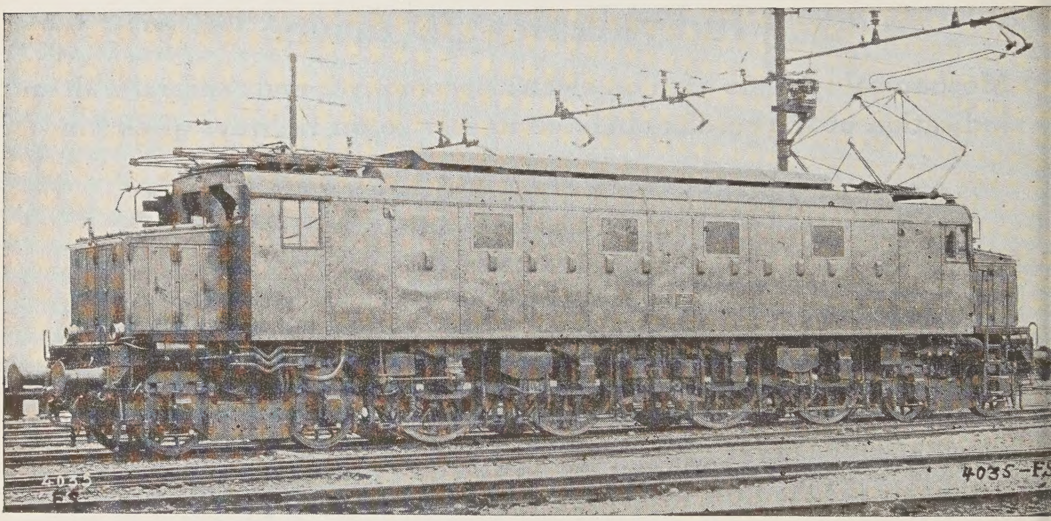
(*) See *Bulletin of the International Railway Congress Association*, Nos. of September, October and December 1947, pp. 823, 885 and 999 respectively, Nos. of February, April, July, October and November 1948, pp. 73, 227, 403 and 591 respectively, January and May 1949, pp. 71 and 379 respectively.

In addition to the characteristics given in fig. 303 with regard to the El.8 class locomotives of the NSB, the following details may also be noted :

| | |
|---|---|
| distance between bogie pivots . . | 5 550 mm. (18′2$^{11}/_{16}$″) |
| distance between bogie and leading truck pivots | 5 000 mm. (16′5″) |
| hourly rating, 4 × 707 — approx. . at the motor armatures at a speed of 70.5 km./h. (43.8 m.p.h.) | 2 800 H.P. |
| maximum operating speed . . . | 110 km./h. (68 m.p.h.) |
| transmission gear ratio . . . . | 1:3.25 |
| adhesive weight . | 60 tons (59.05 Engl. t.) |

the driving axles have no transverse play.

These 16 Norwegian NSB class El.8 locomotives have axles fitted with Isothermos boxes, differing in this respect from the Swedish locomotives, which are fitted with SKF roller-bearing boxes. The mechanical part of these locomotives was built by the « Thunes mek. Vaerksted A/S » and the electrical equipment by « Per Kure, Norsk Motor — og Dynamofabrik A/S », both of Oslo.



Photo

Fig. 305. — Electric locomotive Gr.E.428, No. 059 of the Italian State (FS) Railways, type 2-$D_0$-2 (2-$B_0$-$B_0$-2), 4 000 H.P., 130 km./h. (81 m.p.h.) ; 300 of this type in service. Bianchi mechanism. The bogie, with two driving axles and a two-axled carrying bogie, was shewn in fig. 199.

Fig. 304 shows longitudinal and cross-sections of an axle from one of these Norwegian El.8 class locomotives. It will be seen that owing to the small diameter of the driving wheels — 1 350 mm. (4′5$^{1}/_{8}$″) — there are only 5 flexible couplings, instead of the more usual 6 (or 7).

Reference may also be made to an application of the cup-drive (AEG-

Kleinow), which has only now come to notice. In 1934, a prototype *Soviet Russian* locomotive for high speeds (140 km./h. [87 m.p.h.] operating speed), type 2-$C_0$-2, series P.B. 21, No. 21-01, was built. This locomotive, provided with the normal Kleinow mechanism with hollow shaft (see figs. 81, 85, 111, 298, 299, 304, etc.) has an hourly rating of 2 760 H.P. and a tare weight of 131 tons (128.93 Engl. t.), of which 67 tons (65.94 Engl. t.) is adhesive weight. As far as is known, there was, at least up to 1941 when the war in Russia commenced, only one of these locomotives, which was built, it is believed,

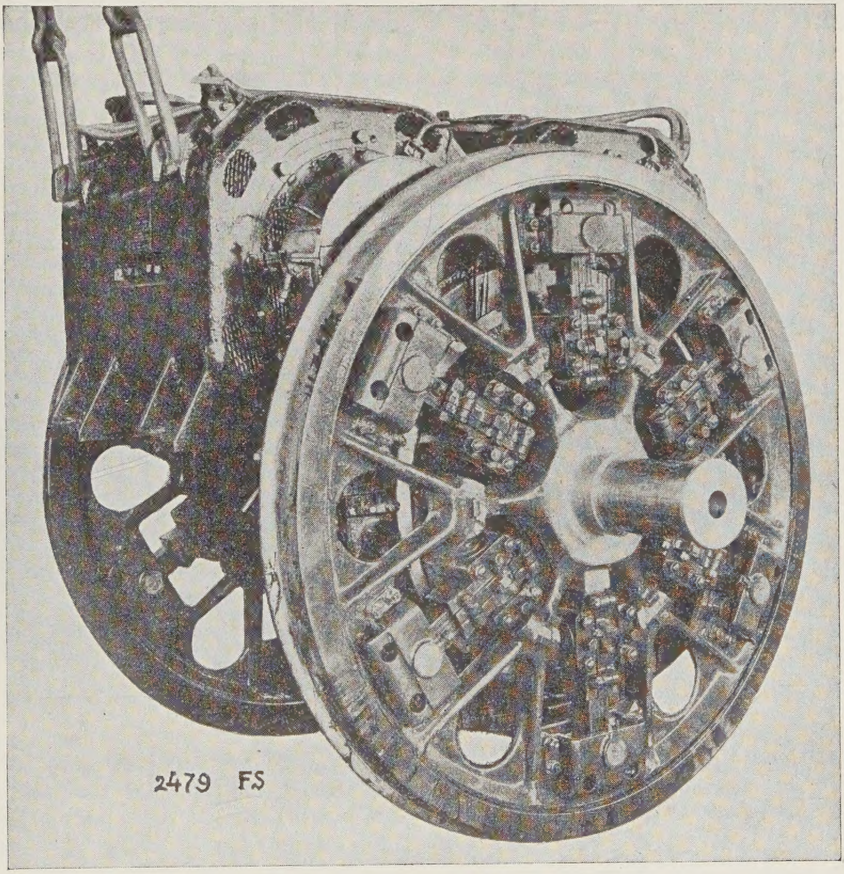


Photo FS.

Fig. 306. — Complete driving axle with twin motor and improved Bianchi flexible mechanism, of the locomotive referred to in figs. 199 and 305. Power 1 000 H.P. per axle.

by AEG at the Henningsdorf-Berlin works. Nothing is known of its behaviour, or history, during these fifteen years. All other electric locomotives of the U.S.S.R. railways were, up to 1944, of $C_0C_0$ type, nose suspended motors, series P.B. 22 (see fig. 78).

the *Negri* mechanisms being noted on the pages with figs. 202-212). The following notes also concern *Italy*.

a) *Locomotives.*

Some further illustrations are given of the Bianchi and Negri mechanisms (with groups of laminated springs) in various applications, as under :

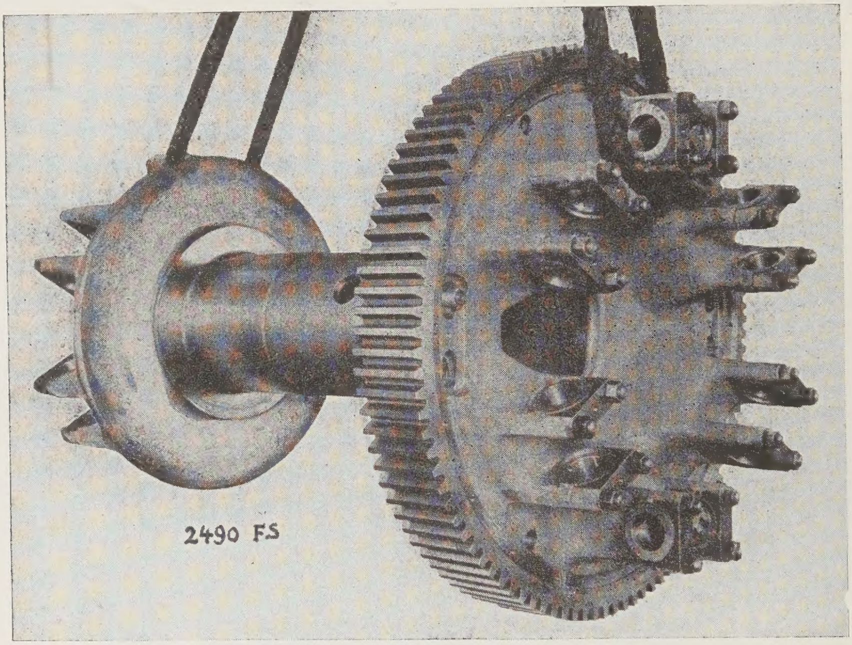


Photo FS.

Fig. 307. — Hollow shaft with bilateral mechanism and unilateral gears, of fig. 306, shewing the double bearings for the rods carrying the laminated spring groups.

With regard to 5), there are no applications, other than those mentioned above fig. 108, right-hand column.

We have dealt under 6) with the original *Bianchi* laminated spring mechanisms (pages with figs. 112, 113 and 210,

— fig. 305, showing locomotive E.428059, class E.428, type 2-$B_0$ $B_0$-2 (192) of the Italian State Railways, F.S., of which we have already shown one of the bogies (half-set of wheels with one driving and one guiding bogie) in fig. 199 and a spring unit (set) in fig. 113;

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(192) This series of locomotives, built to the design of the Italian State Railways, by the main Italian industrial works, was shown only in parenthesis on page 68 (bottom of left-hand column) of **Cde. indiv.** The Italian F.S. put into service from 1932 onwards, 300 locomotives of this type, 4 000 H.P. hourly rating, tare 132 tons, 130 km./h. (80.77 m. p.h.) as mentioned on the page with fig. 112. See also note (120).

— fig. 306, showing a complete driving axle, with twin motors, of the same locomotive. It will be noticed that this incorporates some improvements on that shown in fig. 140 of **Cde. indiv.**;

— fig. 307 showing the complete monobloc hollow shaft of the axle shown in fig. 306, with the unilateral gear wheel and six pairs of bearings for the couples (bilateral drive) of laminated spring sets. These three illustrations are all of Bianchi mechanism.

— figs. 308 to 311 show, respectively, two complete driving axles; the axle drive and coupling mechanism, Negri system, with laminated spring units (see figs. 200 and 201) with hollow shaft (see figs. 308 and 309); the bogie with two motors, during erection, with some parts not fitted, such as swing bolster, springs, etc. (fig. 310); and finally the motor block with gears, gearcase and hollow shaft bearings (fig. 311) of the 130 locomotives mixed traffic class Gr.E.424, $B_0$-$B_0$ type, shown in fig. 312 (half-elevation) which have already been mentioned in the pages containing figs. 204-205.

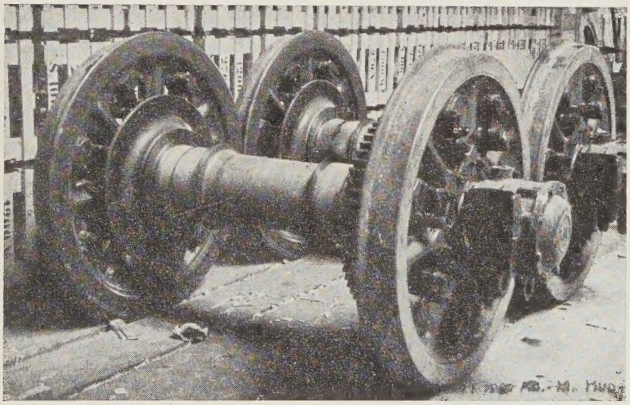

Photo Ad.-M. Hug.

Fig. 308. — Complete driving axles, with hollow shafts and Negri mechanism, similar to figs. 200 and 201, of the $B_0$-$B_0$ locomotives, Gr.E.424, of the FS. Bilateral mechanism with unilateral gears. RIV. roller bearing boxes. See figs. 309 to 312.

These locomotives, about 50 of which were already in service at the end of 1938, have the following characteristics (193), apart from those shown in fig. 312:

| | |
|---|---|
| diameter of driving wheels . . | 1 250 mm. ($4'1^7/_{32}''$) |
| axle load . . . . | 18 tons (17.71 Engl. t.) |
| tare . . . . . | 72 tons (70.86 Engl. t.) |
| weight of mechanical parts . . | 44 tons (43.30 Engl. t.) |
| minimum radius of curved track . | 90 m. ($295'3^3/_8''$) |

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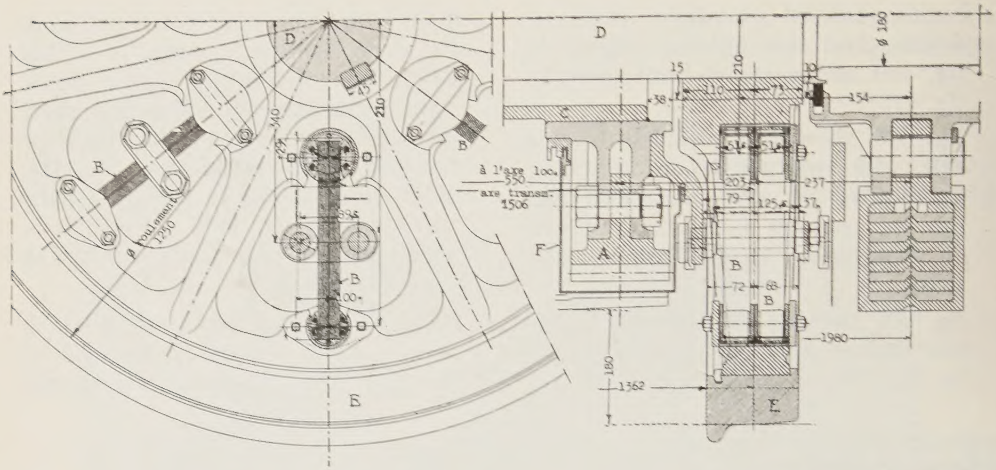
(193) See *Ingegneria Ferroviaria*, Rome, No. 5, Nov. 1946, pp. 1-7 (and continuation) with numerous illustrations, tables, diagrams and references for consultation, by A. D'ARBELA. This review forms a continuation of that mentioned in note (194).



Plan FS.

Fig. 309. — Elevation and section of axle in fig. 308, for wheels of 1 250 mm. (4′1$^{7}/_{32}$″) diameter. (Cf. figs. 200 and 308-312).

A = gear wheel.
B = group of laminated springs (Negri arrangement of springs with enclosed end pivots).
C = hollow shaft.
D = axle.
E = tyre.

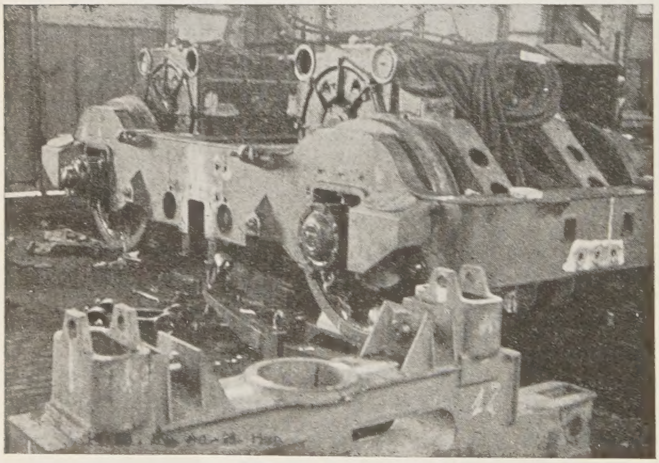


Fig. 310. — Bogie with two driving axles as in figs. 308 and 309, of locomotive shewn in fig. 312, under fitting. The two motors (see figs. 311 and 312) are in position, the swing bolster is in the foreground and the bearing springs are in front of the bogie.

Photo Ad.-M. Hug.

max. speed (gear ratio 16:65, with intermediate gear wheel, that is with double reduction) . . . 100 km./h. (62 m.p.h.)

tractive effort (corresponding to 300 amps.) . . . . 12 000 kgr. (26 455 lbs.)

The electrical equipment, as well as the mechanical part of these locomotives, the

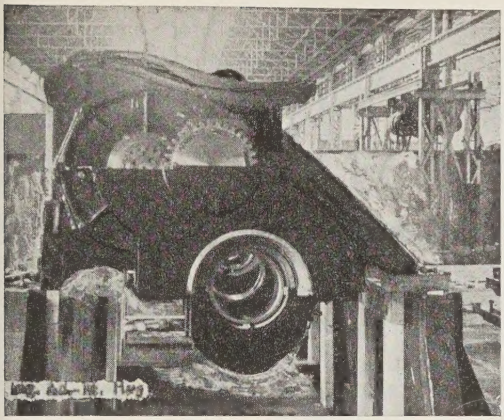
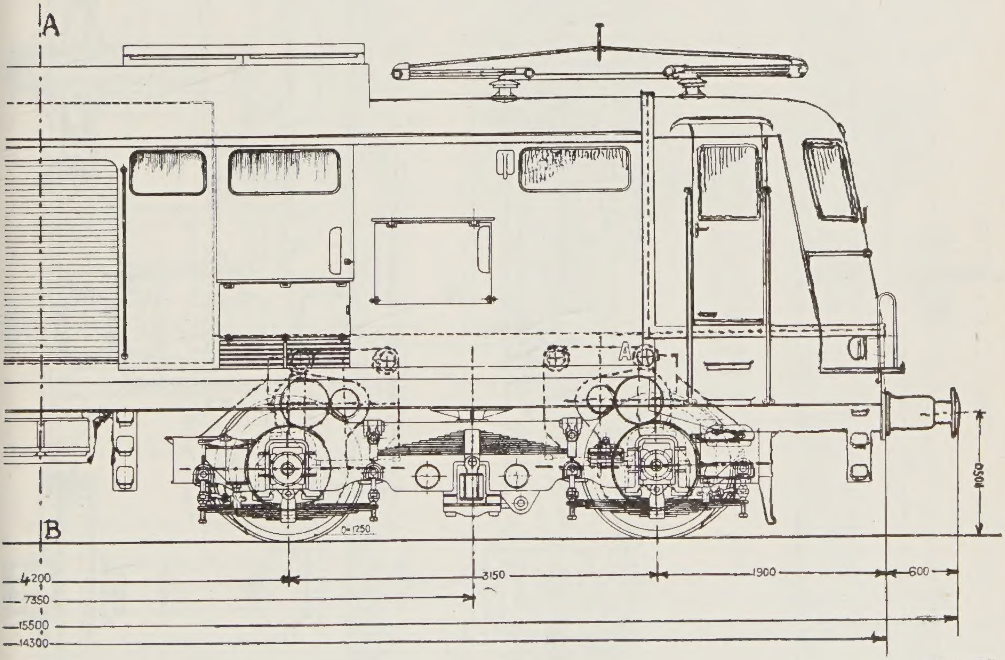


Photo Ad.-M. Hug.

Fig. 311. — Axle motor units, with intermediate gears and hollow shaft bearings. The photograph shews several units (visible through the axle bearings) (see figs. 310 and 312).

first of which were put into service in 1946, was designed by the F.S. technical staff on interesting and novel lines as described in the article referred to in note (193). Several of the E.424 locomotives are equipped with compound-wound motors, in accordance with a system already tried in Italy during the war on locomotive E.626, tests of which are the subject of the article, note (194).

These illustrations, together with figs. 113, 114, 200-203, show the details of the Bianchi and Negri mechanisms for loco-



Plan FS.

Fig. 312. — Half $B_0$-$B_0$ locomotive, Gr.E.424 of the FS. Apart from the cab doors, which are arranged diagonally, one on each side, these locomotives are perfectly symmetrical (inside and outside) in relation to the centre line AB. The centre section serves as a luggage compartment.

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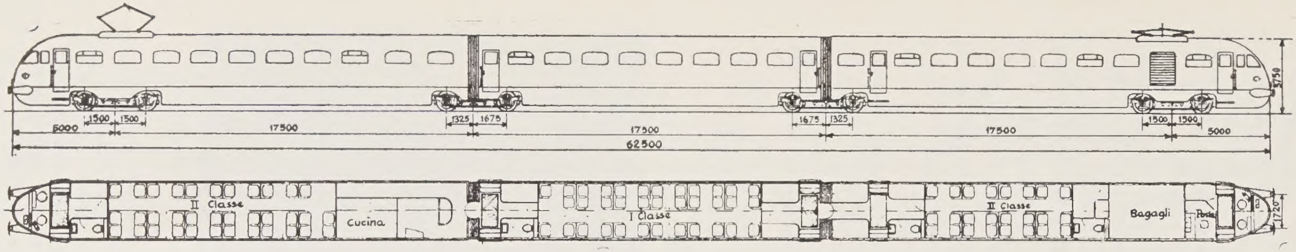
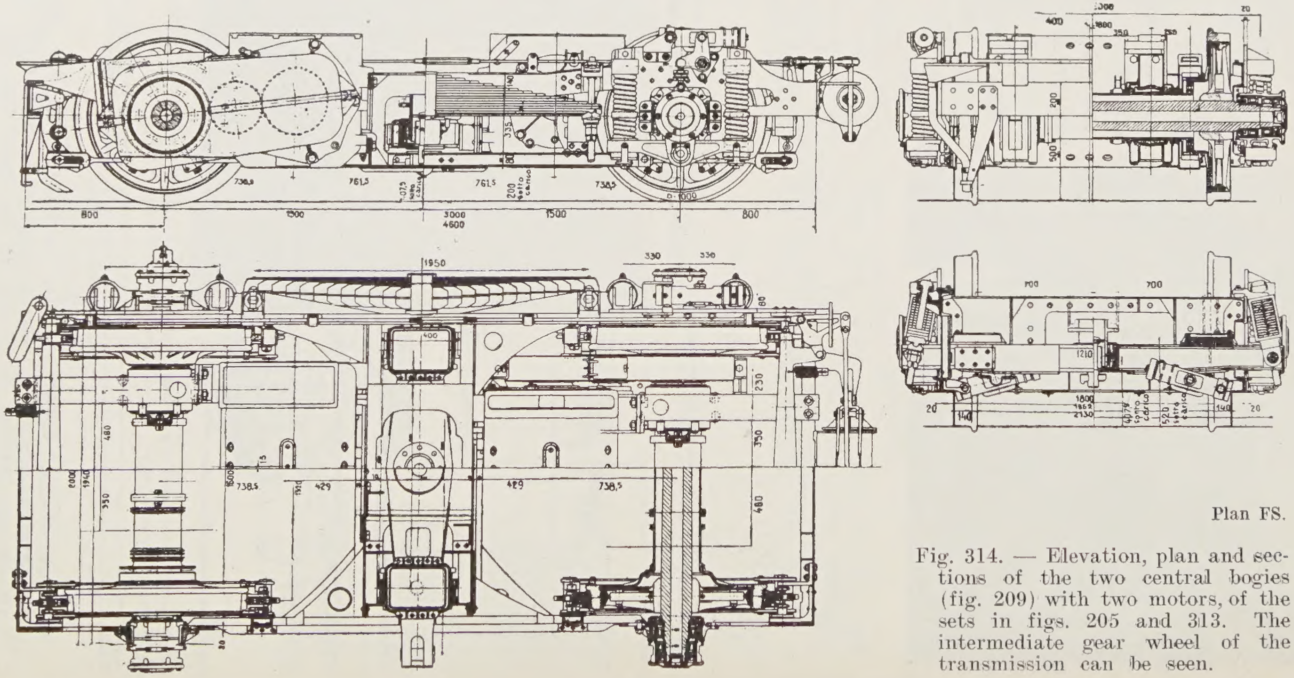
(194) *Rivista tecnica delle Ferrovie Italiane*, No. 5, May 1943. « Experiments with an electric locomotive of 3 000 V. D.C., provided with compound excitation motors, of the F.S. », 16 p., figs. and diagrams, by Martinelli *(in Italian)*.



Plan FS.

Fig. 313. — Dimensioned sketch of ETR, high-speed, articulated electric sets of the FS. Three-coach units, operating speed 160 km./h. (100 m.p.h.) (see figs. 205-209).



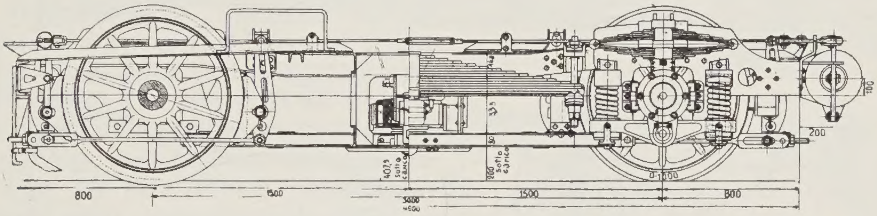
Plan FS.

Fig. 314. — Elevation, plan and sections of the two central bogies (fig. 209) with two motors, of the sets in figs. 205 and 313. The intermediate gear wheel of the transmission can be seen.

motives, in their original and improved forms and as adapted for smaller wheel diameters (see under fig. 113, left-hand column) (195).

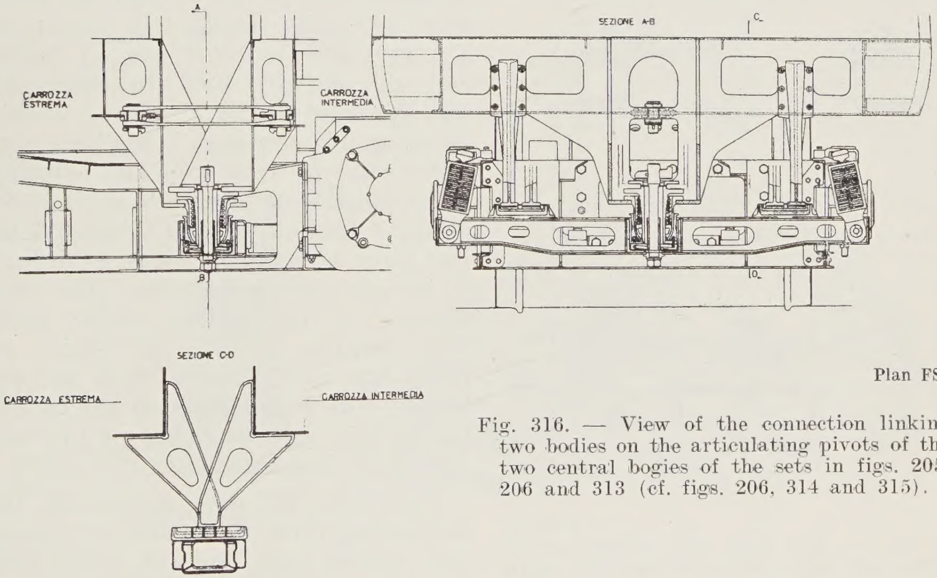
b) *Railcars* (196).

Fig. 114 showed an axle and mechanism with hollow shaft of the « elettrotreni » high-speed articulated triplet sets



Plan FS.

Fig. 315. — Elevation of the same bogie as fig. 314, but with improved suspension and the motors removed.



Plan FS.

Fig. 316. — View of the connection linking two bodies on the articulating pivots of the two central bogies of the sets in figs. 205, 206 and 313 (cf. figs. 206, 314 and 315).

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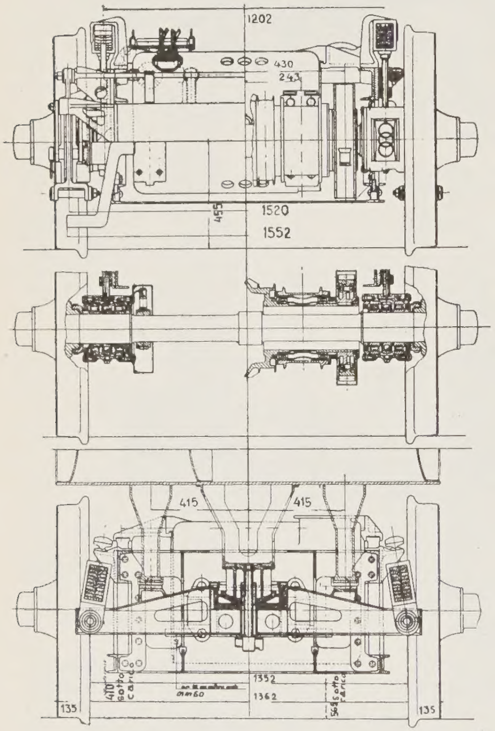
(195) A comparative table of the characteristics of the various Italian locomotives, E.424, E.626, E.326 and E.428 is given on p. 11 of the second publication mentioned in note (120).

(196) See memorandum No. 141, of the « *Rendiconti dell'Associazione Elettrotecnica Italiana, AEI* », Bologna, 1940, « Description of the light electric rolling stock of the F.S., with particular reference to air conditioning in electric trains »*(in Italian)*, by Martinelli. See also *Ingegneria Ferroviaria*, Rome, No. 6, 1948, « Tramway suspension motors on light D.C. railcars », E. Stagni *(in Italian)*. This refers therefore to Chapter II. — *Note.* The publication *Ingegneria Ferroviaria* is a successor to the former *Rivista Tecnica delle Ferrovie Italiane.* »

as in figs. 204 and 209. Figs. 204, 208 and 209 are therefore illustrations of the same mechanism as fig. 114. The bogies of these « elettrotreni » sets are having some improvements carried out, to improve their behaviour at high speeds, and the following comments regarding them may be made.



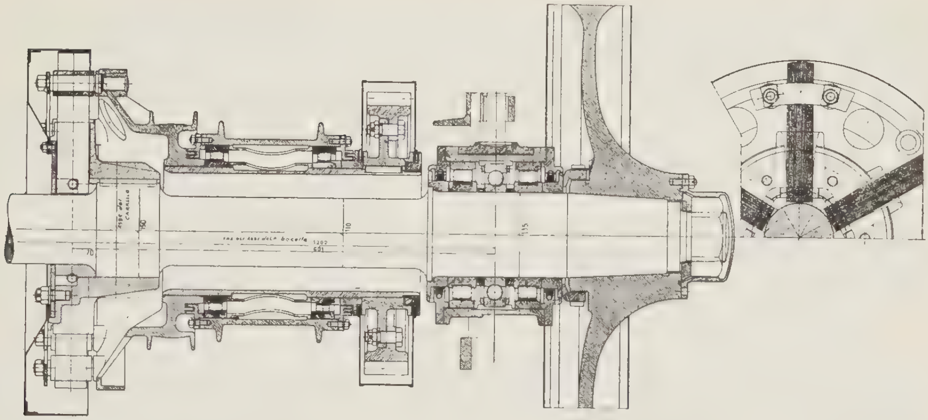
Plan FS.

Fig. 317. — End view and sections of the axles and bogie pivots of fig. 210 (bogie railcars Gr.A.Le 790 and 880, 1938, Italian FS).

Fig. 313 is a dimensioned sketch of one of the ETR sets, series 201 (see also figs. 205-207), whilst figs. 314 and 315 show plans and sections of the bogies; fig. 315 shows that the hydraulic dampers on the boxes have been removed, owing to their high maintenance cost, and their unreliability in operation. The dampers have been retained only on the swing bolsters. The dampers on the boxes have been replaced by a set of flexible automatic shock-absorbers, in which laminated springs work in parallel (instead of the more usual series arrangement, for carriages, with coil springs). Fig. 315 clearly shows this arrangement, which gives, even on very poor track, much better results than the previous hydraulic shock-absorber. Quite recently, trials have been carried out on one of the ETR sets (still in the 201-218 series) with bearing springs of the same design as fig 315, but in Cr-Si-Mn steel, with a tensile strength in excess of 170 kgr./mm$^2$ (107.9 t. per sq. inch) and an elasticity limit in excess of 160 kgr./mm$^2$ (101.6 t. per sq. inch). By using this new steel, it has been possible, with the same size and reducing where possible the resistance surfaces, to obtain a flexibility of 40 % more than that given by normal springs, equivalent to 8.5 mm. per carriage-ton. The compression of the springs, under static load, remains within the limits of 85/90 kgr./mm$^2$ (53.97/57.14 t. per sq. inch). The F.S. intends to extend the use of this suspension and of the new steel to all new motor sets.

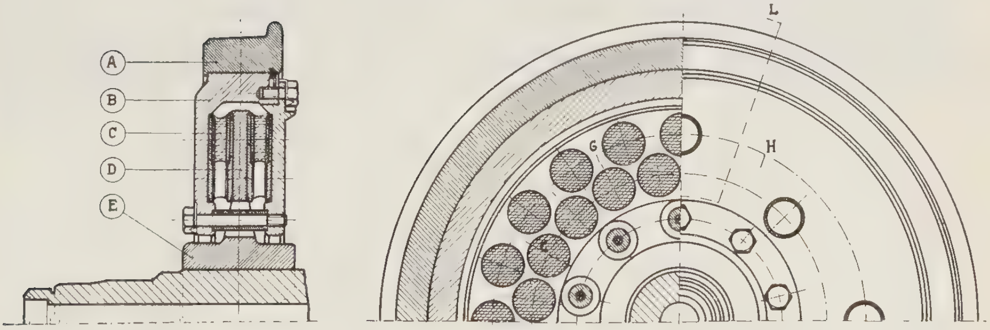
Figs. 316 to 318 show, respectively, the articulating pivot of two successive vehicles; various bogie and axle details and, finally, details of the mechanism between the two wheels on one axle.

On the first of the *new* ETR sets, No. 301, which is under construction and should be placed in service towards the end of 1949, or early 1950, an attempt is being made further to improve the stability and springing and tests will be



Plan FS.

Fig. 318. — Details of the central sketch of fig. 317, shewing the Bianchi railcar mechanism (same axle as fig. 210).

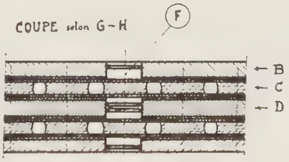


COUPE selon I-L

A = tyre.
B = outer cover and wheel disc.
C = rubber discs.
D and E = inner wheel disc and centre (in one piece).
F = hole for ventilation and to allow centring of rubber discs.

*Note.* — The portion AB can also be made monobloc (without separate tyre).

COUPE selon G-H



Plan SAGA.

Fig. 319. — Various sections and elevation of SAGA flexible wheels, which are on trial on the new fast Italian rail set (ETR) No. 301 (1949).

made with rubber discs fitted in accordance with the SAGA-Pirelli system (see fig. 319). It would be premature to discuss this arrangement now, whilst it is still under construction; the arrangement is, however, noteworthy, since it is intended for speeds up to 160 km./h. (100 m.p.h.) in normal service, and also, since the sets are required to operate on mountain gradients (Bologna-Florence).

We have already noted similar applications (SAB and SAGA systems) on some $B_0B_0$ locomotives on the French SNCF (see page containing fig. 280) and we shall show later triai applications of the SAGA arrangement on some other French locomotives (fig. 341). In the appendix to Chapter VI we shall show a modern tramway bogie (ATM-Turin) also fitted with SAGA flexible wheels, but of a different type (fig. 369, see also 255 and 251-254), as well as the wheel dismantled (fig. 370); fig. 371 will show the flexible wheel used on the new motor vehicles (now under construction) of the Geneva tramways.

In fig. 210 is shown a completely fitted axle as used on railcars without trailers, type ALe, series 880 and 790, mentioned in note (196).

Fig. 320 shows the twin railcars, each having two driving bogies, which can also operate with an intermediate, non-motor, coach, the whole set being driven by multiple units.

The railcars for use with trailers, type ALe 883, which have the same driving bogies as the ETR sets of the 207-214 series, have the following characteristics :

| | |
|---|---|
| hourly rating . . | 815/900 H.P. |
| maxim. operating speed . . . . | 120 km./h. (75 m.p.h.) |
| tractive effort at rail . . . . . | 2 900 + 1 200 kgr.<br>(6 394 + 2 645 lbs.) |
| diameter of driving wheels . . | 1 110 mm. ($3'7^{23}/_{32}''$) |
| axle load (empty) | 16 tons (15.74 Engl. t.) |
| tare . . . . . | 54 tons (53.14 Engl. t.) |
| weight of electrical equipment . . | 16 tons (15.74 Engl. t.) |

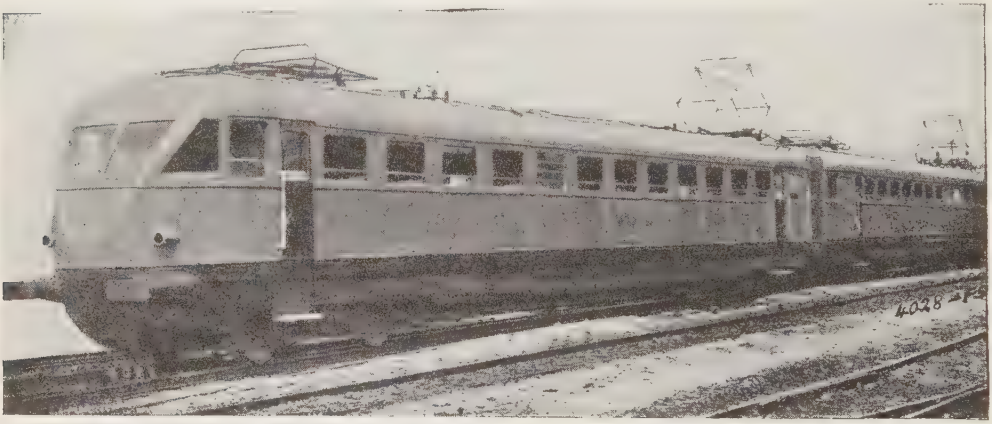


Photo FS.

Fig. 320. — Double railcar on four bogies and multi-unit drive, Gr.E.24 of Italian FS. Power 2 × 560 H.P., 130 km./h. (81 m.p.h.). Bianchi mechanism.

It may also be mentioned that on axles in accordance with fig. 210 with single flexible mechanism arranged in the centre of the axle, on the end of the hollow shaft, there is no double reduction through the gears, the intermediate gear wheel being provided simply for the purpose of achieving the requisite distance between the axle and motor centre lines. The vertical bearing plate with four bolt holes, which can be seen in fig. 210, serves for fixing the motor, which rests at the other end on the bogie frame through *transverse* bearers, i.e. parallel to the axle [197], whilst in the arrangements shown in figs. 114 and 204 (see also figs. 208 and 209) the bearers follow the more usual longitudinal line. Finally, the axles — still referring to fig. 210 — permit the wheels to be unbolted to allow for fitting or dismantling of the mechanism.

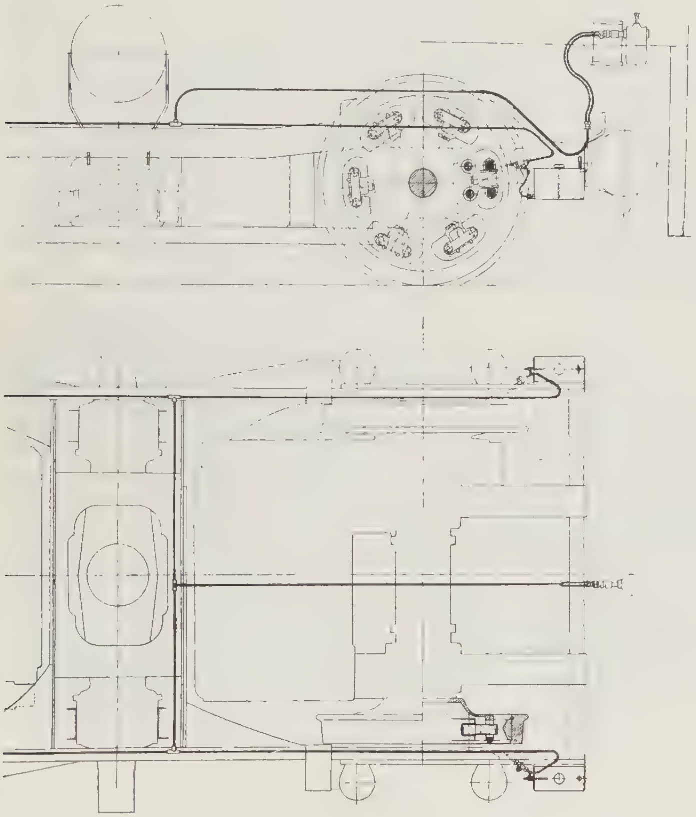


Fig. 321. — Forced lubrication arrangement (compressed-air oil vapouriser) of the Negri railcar mechanism shewn in fig. 202.

The Negri spring mechanism, shown in figs. 211 and 212, are also used on axles as in fig. 210 and with the intermediate gear wheel. This mechanism works as follows : the coil spring and the levers, which form a T shape (instead of a U shape as in fig. 202) are keyed to the axle whilst the roller bearing is part of the hollow shaft. When the couple is acting in a right-hand direction, the left-hand roller (see the vertical lever in fig. 211) bears on the T lever, which compresses the left-hand spring. On the other hand, when the couple acts by rotation in the reverse direction, the lever is thrust by the right-hand roller and compresses the right-hand spring (198).

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[197] See fig. 42 of the first publication mentioned in note [120].

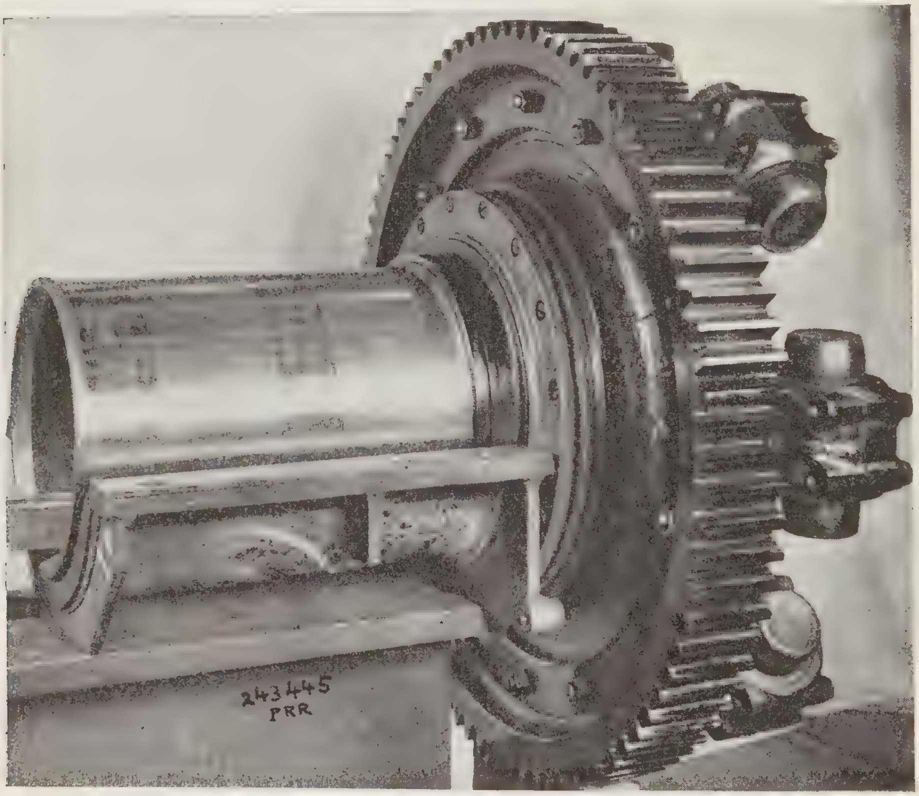

Photo PRR.

Fig. 322. - View of rubber drive mechanism with gear wheel and stub hollow shaft of Pennsylvania RR., unilateral drive locomotives (cf. figs. 70 and 74 quill cup drive, with figs. 76 and 77, which have unilateral gears but bilateral driving mechanism).

To conclude these Italian applications, we may note an interesting forced lubrication arrangement on the Negri mechanism (fig. 321) and also the pincer recoil arrangement on the 2-axle carrying

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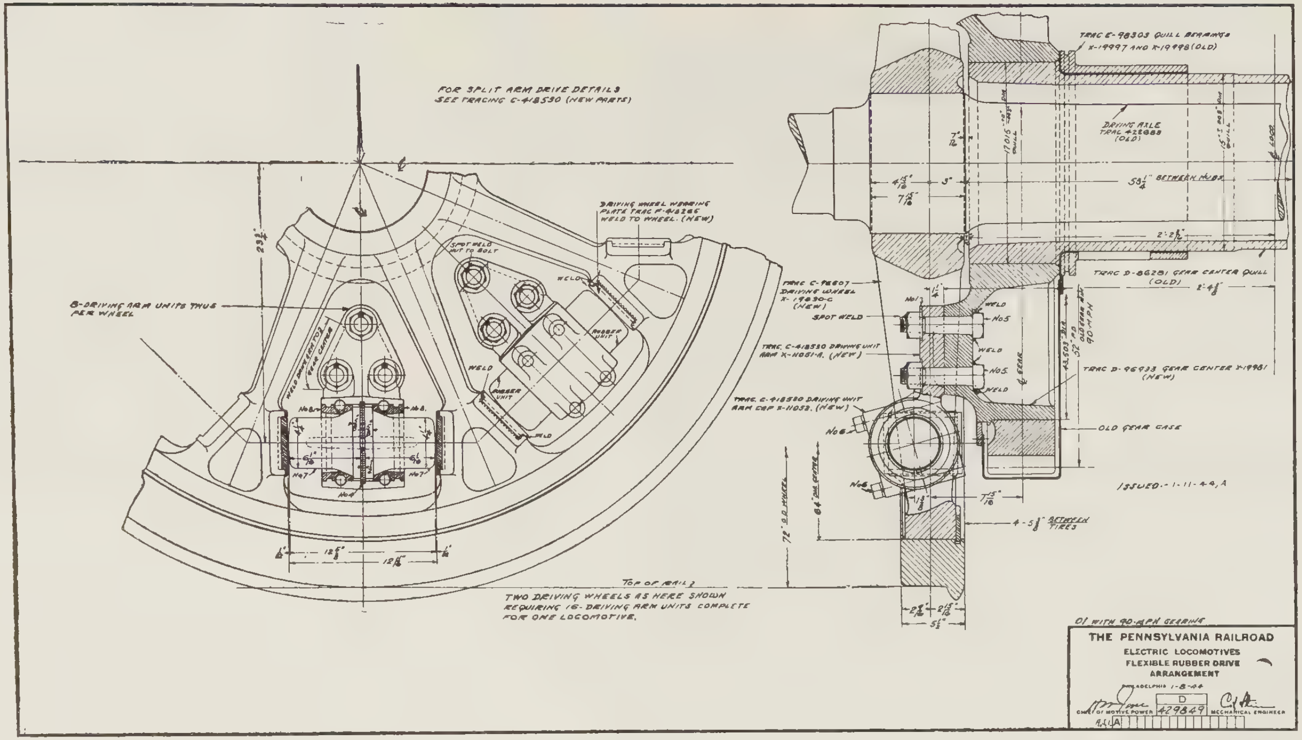
(198) See the double illustration, fig. 49 of the first publication in note (120).


FOR SPLIT ARM DRIVE DETAILS
SEE TRACING C-418530 (NEW PARTS)
8-DRIVING ARM UNITS THUS PER WHEEL
WELD DRIVE ARM TO GEAR CENTER
SPOT WELD NUT TO BOLT
DRIVING WHEEL WEARING PLATE TRAC F-416266 WELD TO WHEEL. (NEW)
WELD
RUBBER UNIT
No 8
No 7
No 4
$6\frac{1}{16}$"
$23\frac{1}{4}$"
$12\frac{5}{8}$"
$12\frac{15}{16}$"
TOP OF RAIL
TWO DRIVING WHEELS AS HERE SHOWN REQUIRING 16-DRIVING ARM UNITS COMPLETE FOR ONE LOCOMOTIVE.
72" O.D. WHEEL
64" DIA CENTER
TRAC C-96807 DRIVING WHEEL X-19830-C (NEW)
SPOT WELD
TRAC C-418530 DRIVING UNIT ARM X-11051-A. (NEW)
TRAC C-418530 DRIVING UNIT ARM CAP X-11052. (NEW)
No 1
No 5
No 6
$1\frac{1}{4}$"
$7\frac{15}{16}$"
$4\frac{15}{16}$"
3"
$7\frac{1}{2}$"
17.015" QUILL DIA
DRIVING AXLE TRAC 428688 (OLD)
$53\frac{1}{4}$" BETWEEN HUBS
15" I.D. QUILL DIA
℄ LOCO
2'-$2\frac{1}{2}$"
2'-$4\frac{1}{8}$"
TRAC E-98303 QUILL BEARINGS X-19997 AND X-19998 (OLD)
TRAC D-86281 GEAR CENTER QUILL (OLD)
43.503" DIA
52" P.D.
OLD GEAR DIA 90 MPH
℄ GEAR
TRAC D-96933 GEAR CENTER X-19981 (NEW)
OLD GEAR CASE
ISSUED - 1-11-44, A
4-$5\frac{1}{8}$" BETWEEN TIRES
$2\frac{9}{16}$"
$2\frac{15}{16}$"
$5\frac{1}{2}$"
O1 WITH 90-MPH GEARING
THE PENNSYLVANIA RAILROAD
ELECTRIC LOCOMOTIVES
FLEXIBLE RUBBER DRIVE
ARRANGEMENT
PHILADELPHIA 1-8-44
CHIEF OF MOTIVE POWER
D
429849
MECHANICAL ENGINEER
A

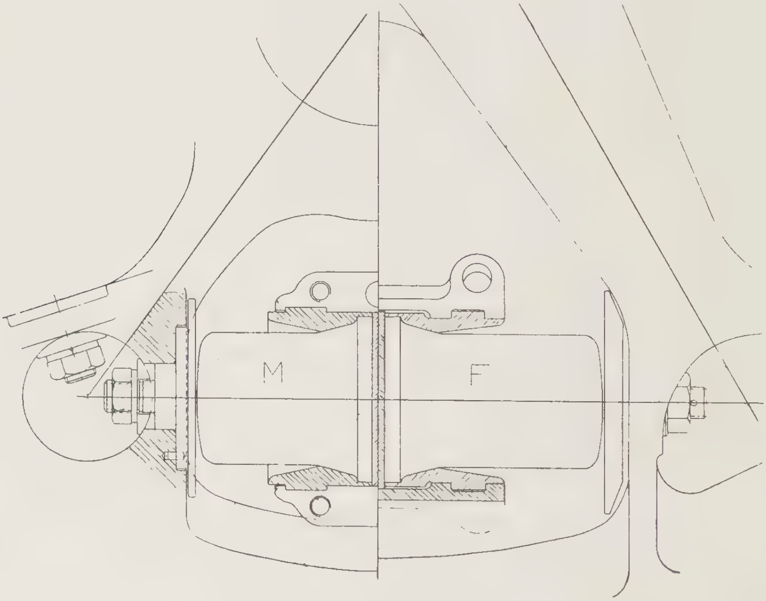
Plan PRR.

Fig. 323. — PRR. rubber drive mechanism for 0.1 class locomotives of 145 km./h. (90 m.p.h.) (see figs. 70, 117, 293 and 322).

bogies of the E.326 and E.428 class; in this case it is used on a leading bogie at speeds up to 150 km./h. (93 m. p.h.) (199).

In continuation of **Part Two** of Chapter IV and the descriptions of the « cup drive » mechanism, with rubber blocks, also known as « rubber drive », we shall mention the applications in the Scandinavian countries, but first, in regard to the remarks alongside figs. 114 and 115, we can include fig. 322 showing the gear-wheel and rubber-block couples fitted on the stub hollow-shaft of a Pennsylvania Railroad locomotive. This is a unilateral mechanism and is fitted to locomotives of class 01 (see fig. 293). Comparison may be made with fig. 70, mechanism with monobloc parts, couples and springs.

Fig. 323 shows the mechanism fitted on an axle, as it is at present, on a « class 01 » locomotive, type 2-$B_0$-2, No. 7850, of the PRR, with gearing for speeds of 145 km./h. (90 m.p.h.) (see fig. 293). The close similarity to fig. 322, particularly in the lay-out, will be seen,



Plan ASEA.

Fig. 324. — Arrangement of P.R.R. rubber drive on Swedish S.J. locomotives, class M. $C_0$-$C_0$ type, for freight traffic on the left, whilst on the right is the arrangement used on the F class, 1-$D_0$-1 locomotives for express traffic (cf. fig. 117).

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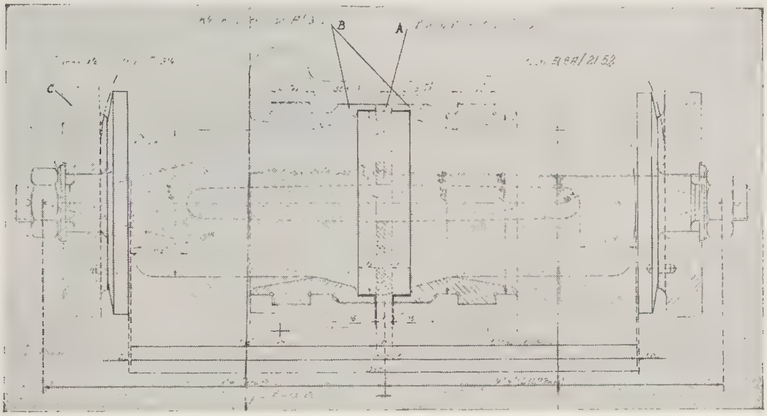
(199) See the bottom of page 11 in the second publication in note (120). It is known that the present general tendency, whilst in some respects only recently showing itself, is to reduce, and even to eliminate, the number of carrying axles. See, for example, fig. 244 compared with 44-45, 282-283 with 281, etc.

by comparison with fig. 117, which shows the rubber drive mechanism as fitted on the GG1 class locomotives, type 2-$C_0$+$C_0$-2 (see table A, following fig. 70), there are a number of differences, particularly in the fitting of the units.



Plan NSB.

Fig. 325. — Arrangement of PRR. rubber drive on Norwegian (NSB) locomotive No. 2054 (trial fitting, cf. figs. 117 and 324).

A = foundation plates, separating two rubber blocks of a flexible unit.

B = base plates, for locating the rubber blocks in the required position on the plates A.

C = wheel spokes, to which are fitted the bearing plates.

In connection with the First Part of Chapter IV, we mentioned the conversion of the *Swedish* S.J. locomotives, class « F », Nos. 601 and 624, type 1-$D_0$-1, on which the AEG-Kleinow « quill cup drive » was replaced by rubber blocks in accordance with the Pennsylvania R.R. « rubber drive » arrangement.

Fig. 324 shows the arrangement of the rubber block couples, supplied by the Goodyear Supply Co. of Philadelphia (Pa., U.S.A.). On the right is the arrangement of the « F » class, 1-$D_0$-1, (figs. 91, 92 and 298) and, left of the vertical centre line, the arrangement on the « M » class, $C_0$+$C_0$, locomotives, as shown in figs. 93 and 123. Actually, two of the locomotives of this type have been converted similarly. The rubber couple blocks are therefore identical with fig. 117.

On locomotive No. 601, first results in operation have not been altogether satisfactory, the rubber being insufficiently resistant to oil.

Il is not always possible, in fact, to avoid oil splashes from the gear case or from the oilways in the hollow shaft arms. It may be that the couple bearing plates (and therefore the rubber blocks on the converted machines) have been oiled in mistake by local oilers or by the shed staff, as this is the usual procedure on engines with steel couples.

As regards the two Swedish S.J. locomotives, class « M », type $C_0+C_0$, for freight services (which have Meyfarth-Secheron mechanism, see figs. 93 and 123 and text on pages including figs. 124 and 126), converted, as has just been stated, in a similar manner, these are Nos. 606 and 610. On these, the « rubber drive » is arranged in the same way; the risk of oil splashes is less on this type of locomotive. The arrangement is shown in fig. 324 (left-hand side). The Swedish Railways have apparently decided to equip all « F » and « M » class locomotives with rubber drive in replacement of the original mechanisms shown, the cost of maintenance being reduced according to the trial results, to about one-fifth of the present cost per locomotive/kilometre.

It may be added that, according to the experience so far gained on the Pennsylvania R.R., the rubber couple-blocks have a life equal to a service of 300 000 km. (186 000 miles).

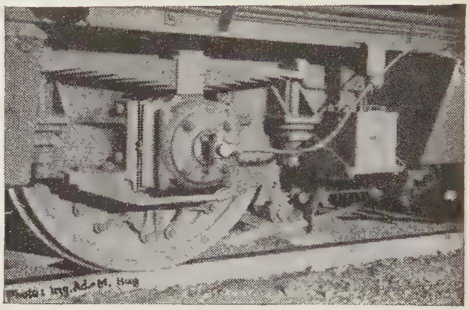
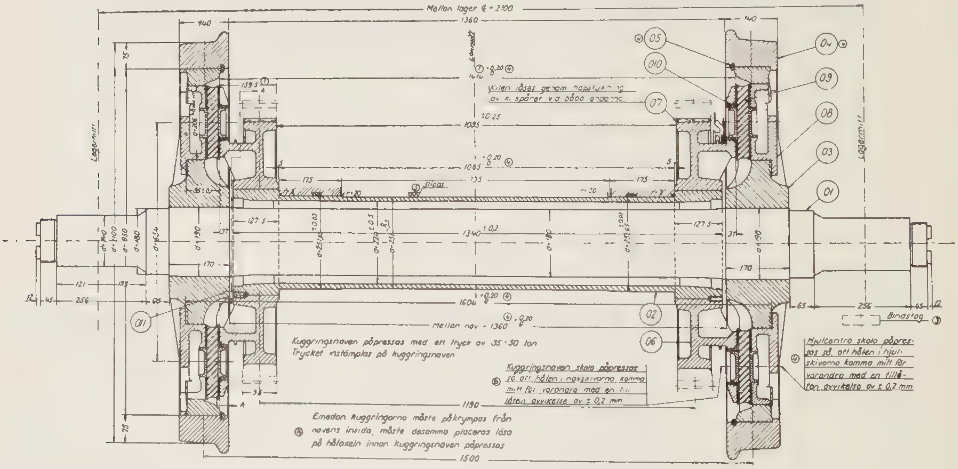


Photo Ad.-M. Hug.

Fig. 326. — Exterior view of axle of $B_0$-$B_0$ locomotive, HD class, Swedish SJ, shewn in fig. 297.

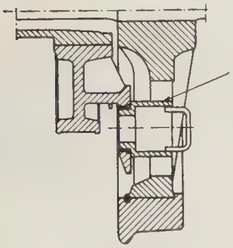

Mellan lager ℄ = 2100
1360
440
140
05
010
07
04
09
08
03
01
02
06
011
Lagermitt
1085
1035
735
175
175
1340
1604
1190
1500
170
170
127.5
127.5
256
256
121
65
65
Slipas
Kilen löses genom hopslukning av k. spåret v.g. bådo gradning
Mellan nav = 1360
Kuggringsnaven påpressas med ett tryck av 35-50 ton
Trycket instämplas på kuggringsnaven
Kuggringsnaven skola påpressas så att hålen i navskivorna komma mitt för varandra med en tillåten avvikelse av ± 0,2 mm
Emedan kuggringarna måste påkrympas från navens insida, måste desamma placeras lösa på håloxeln innan kuggringsnaven påpressas
Hjulcentra skola påpressas så att hålen i hjulskivorna komma mitt för varandra med en tillåten avvikelse av ± 0,2 mm
Bindstag

Plan ASEA.

Fig. 327. — Section through centre line of axle of locomotive of figs. 297 and 326, showing the flexible driving mechanism ASEA (Sweden), which has replaced the Secheron 1 mechanism on this locomotive, for trial purposes.

01 = axle.
02 = hollow shaft.
03 = wheel centre.
04 = tyre.
06 = gear wheel.
07 = geared rim.
08 = outer cover plate (see figs. 326 and 329).
09 = rubber disc.
010 = casing for rubber disc.
011 = stop pin.

In the previous remarks on *Norwegian* (NSB) class El.8 locomotives, it was stated that No. 2054 (series shown in figs. 302-304) the AEG-Kleinow quill cup drive had been replaced by rubber block couples, Pennsylvania type, for trial purposes. Its behaviour has been satisfactory. Fig. 325 shows the arrangement as used on this locomotive.

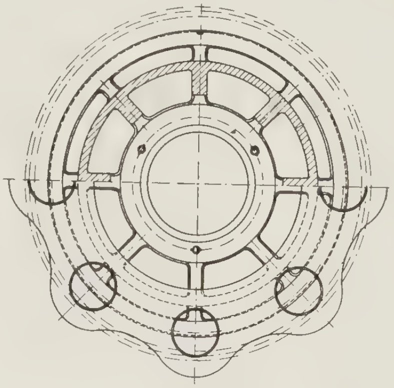


Plan ASEA.

Fig. 328. — Device for ensuring concentricity of the two bearing faces of the rubber disc, by setting to a desired position. No longer used, the operation having been simplified. See figs. 327 and 329.

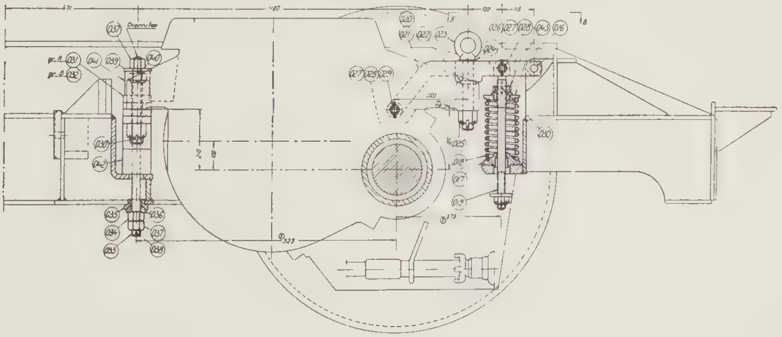
Still dealing with *mechanisms having rubber units*, we now come to a completely new form of coupling between the hollow shaft and the wheels. This is a mechanism using rubber discs, by the ASEA Works of Västerås, Sweden, already mentioned.

This mechanism has so far been used twice in slightly different ways, but both based on the same principle, and having the same components; one on a locomotive and the other on a railcar set.



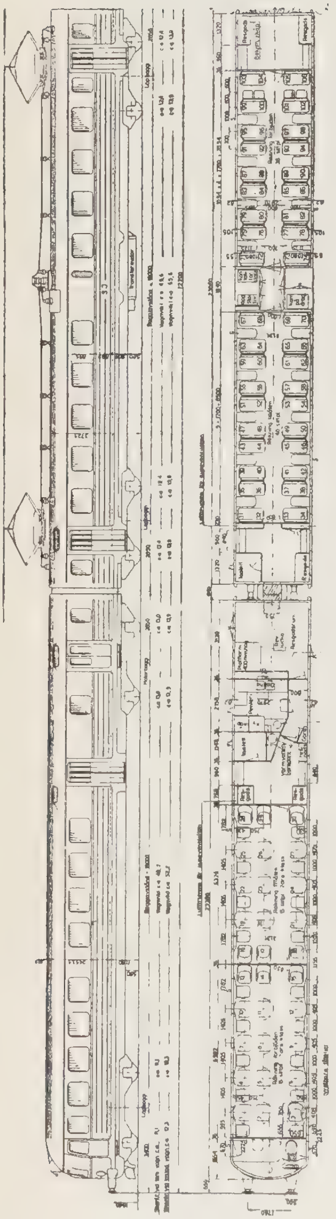
Plan ASEA.

Fig. 329. — Arrangement for mounting the eight rubber discs against the gear wheel body. The lower half shews the body of the gear wheel, seen from outside; the top half the section of the gear wheel body between the wheel and the rim. The three pins, 011, at the centre, are for locking (fig. 327).



Plan ASEA.

Fig. 330. — Arrangement for suspension of motors on the axles of the Hd locomotives (figs. 297, 326 and 327).



Plan ASEA.

Fig. 331. — Elevation and plan of the Swedish SJ. sets, triplets, 1948, Xoa5 class, Nos. 216 to 221. This illustration shews only one outer vehicle and the middle one; the car not shewn, outer, right-hand side, has an interior arrangement similar to the middle coach and outside, two passenger entrances (apart from the cab door), one of which is located almost centrally between the bogie pivots, the other over the axle nearest the articulation. Bogies 2 and 5, that is the inner bogies of each of the two end vehicles, are driven; the other four are carrying bogies. Total number of seats, 178, including 30 second class (left-hand vehicle, including kitchen).
Overall length of triple set, 72.2 m. (236′10⁵/₈″). The weights and axle loads shewn, both nett and gross, are approximate (see text).

*Locomotives.*

The text above fig. 59, and the early portion of this supplement dealing with Chapter IV mentioned four $B_0$-$B_0$ locomotives of the Swedish (SJ) railways. These are the « Hd » class, series Nos. 551-554. Locomotive No. 552, which is shown in fig. 297, was fitted with Secheron 1 mechanism like the others, and like those of the former G.B.J. (Göteborg-Boras, fig. 296). Following numerous spring breakages, however, — probably because of the reasons mentioned in the text alongside fig. 299 — this mechanism was replaced in 1947 by the new ASEA mechanism shown in figs. 326-329. This coupling is a simple rubber disc arrangement, of the type shown in fig. 255 for the SAB flexible wheels, but with the discs vulcanised on steel plate discs with concentric ribbing. The arrangement of these discs is shown in fig. 327 (and, for railcar sets, in 336).

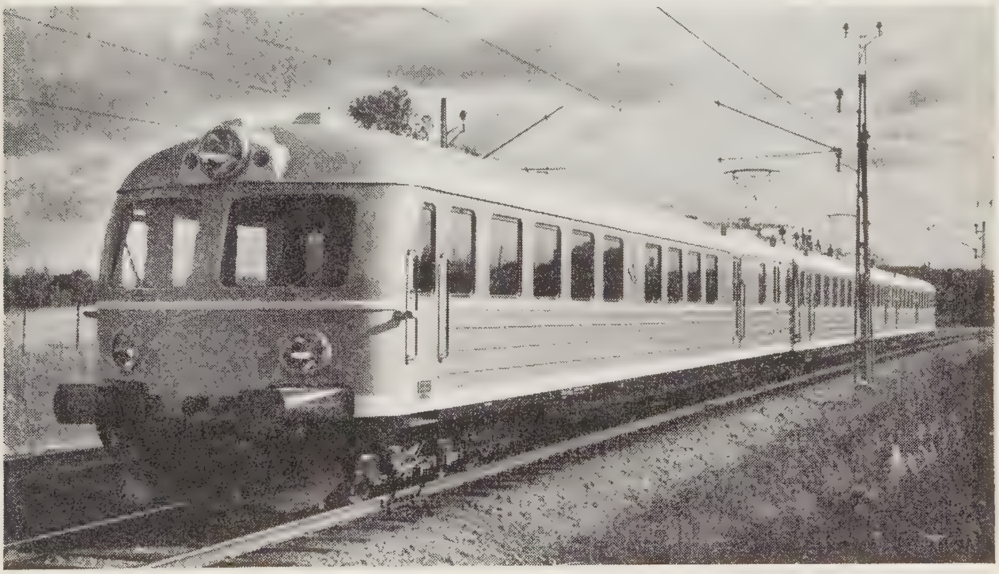
These discs, 8 in number and bilateral, as are the gears, are fixed by one of the faces to the driving wheels, between the spokes, and on the other side to a washer plate which forms part of the main gear wheel on the hollow shaft. The appearance of the mechanism outside the wheels can be seen in fig. 326. Fig. 327 is a longitudinal section through the centre line of the driving axle. The gears have oblique teeth. Figs. 328 and 329 are detail diagrams and fig. 330 shows the suspension of the motor. In view of the good results obtained from locomotive No. 552, on which the Author had an opportunity of travelling in 1948, another locomotive of the same series will also be converted. In this case the mechanism will obviously need to be adapted to the existing axles and hollow shafts, which are fitted with spring mechanism.

This new ASEA mechanism has, moreover, a certain similarity to that shown in figs. 197 and 198, particularly in its new form with rubber blocks instead of spiral springs (see fig. 342).

*Railcar sets.*

During Sept. 1948, the Swedish S.J. railways placed in service 6 railcar sets of three fixed coaches, with 6 bogies, as shown in figs. 331 and 332. These are a kind of articulated railcar set, but with independent bogies, having a certain similarity to the Swiss vehicles shown in figs. 175 and 177 (with two coach units) and particularly to those in figs. 134 and 135 (which have three coach units).

These sets (200) are numbered 216 to 221 in the S.J. series and are classified Xoa5; they work shuttle services on the following lines : Stockholm-Göteborg (456 km. [281.8 miles]); Stockholm-Örebro (223 km. [138.5 miles]); and Stockholm-Mjölby (241 km. [149.7 miles]). Figs. 332 and 331 show, respectively, one of the sets in service, and a plan and elevation (201). Bogies 2 and 5 (i.e. the second and the next to the last in either



Cliché SKF.

Fig. 332. — Railcar set Xoa5 (fig. 331) No. 216, in service on the Stockholm-Göthenburg line.

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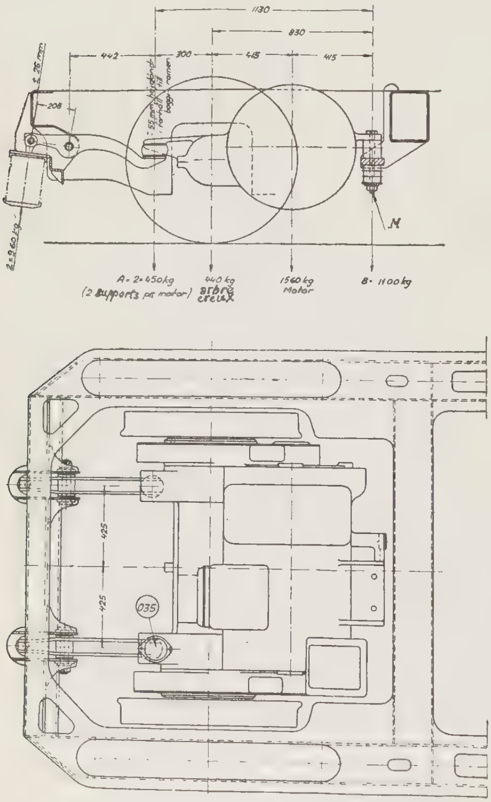
(200) See *ASEA's Tidning*, Västerås, No. 5-7, 1948, pp. 67-68, « GDG-Expressen », H. ÖFVERHOLM. Pp. 59-67 describe the earlier 4-coach sets with nose-suspended motors.

(201) The author had the opportunity on the 16th Aug. 1948, of travelling on the first official trial run from Stockholm to Göteborg. At present, the commercial speed is limited to 95 km./h. (60 m.p.h.), but it will be increased when certain sections of the line are renovated. The weight of rail is 40 kgr. per metre run.

direction) are driven, each by two motors (fig. 339, with automatic ventilation, since they are used only at two-thirds capacity), or a total of four motors of 340 H.P. each, corresponding to a total hourly rating of 1 340 H.P. The maximum permitted operating speed is 130 km./h. (81 m.p.h.). The gross laden axle loads are 11.7 tons on the outside bogies, 13.5 tons on the driving bogies and 13.2 tons on the intermediate bogies, so that the total loaded weight of the sets is 154 tons (tare 136 tons, the load being 18 tons, of which 15 tons is allowed for passengers, 1 ton for luggage, two tons for water carried in the tanks and for sand, and 250 kgr. [550 lbs.] for the buffet equipment, etc.).



Plan ASEA.

Fig. 333. — Elevation and plan of the traction motor suspension in the bogie frame, shewing the weight distribution (sets in figs. 331 and 332).

M = resilient bearing for nose of fully-slung motor.

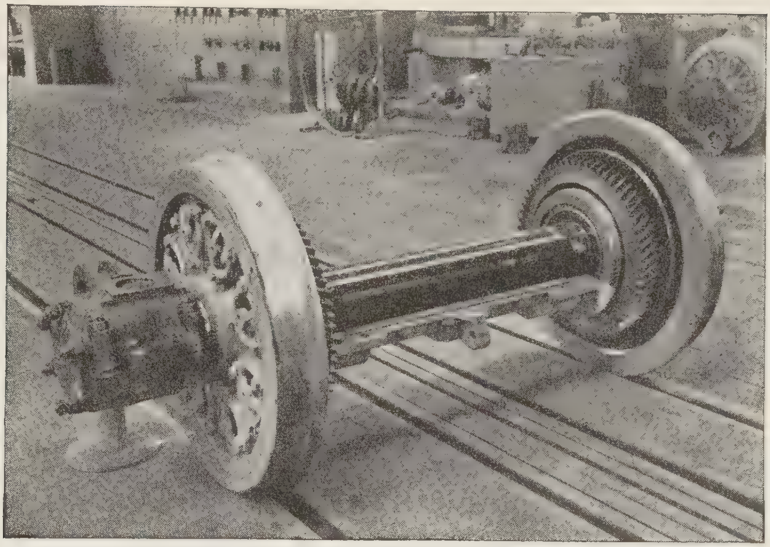
For the four sets Nos. 216-219, the mechanical parts were built by the Ab. Svenska Järnvägsverkstäderna Works, Linköping, and for the remaining two sets, Nos. 220 and 221, by the Kockums Mekaniska Verkstads A.B., Malmö. The electrical equipment, and the transmission, for all six sets were provided by the ASEA Works, Västerås.

The transmission of the driving axles of these sets was specially designed and in consequence is somewhat different from that shown in figs. 326 and 327.

Fig. 333 shows the suspension of the motors and the weight distribution, fig. 334 a driving axle with mechanism, hollow shaft and gear wheels (SKF roller bearing boxes). Figs. 335 and 336, respectively, show a vertical section through the axle and a horizontal section through the mechanism and gear wheel, whilst fig. 337 shows the mechanism on the outside of the wheels.

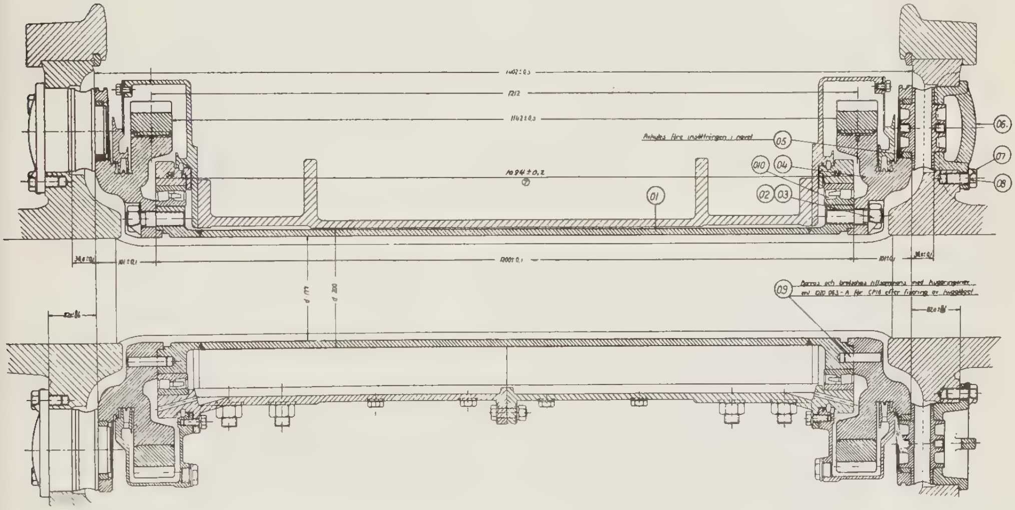
The play allowed between the two metal discs, vulcanised on one india-rubber disc, is approximately 5-6 mm. ($^{13}/_{64}''$ to $^{15}/_{64}''$), the shear stress is therefore in the region of 1.5 kgr./cm$^2$ (21 lbs. per sq. inch), which is rather low. The actual play produced, however, remains within the limits of 2-4 mm. ($^{5}/_{64}''$-$^{5}/_{32}''$). The play between the axle and the hollow shaft is 13.5 mm. ($^{34}/_{64}''$), giving an adequate margin.

Obviously it is not yet possible to



Cliché SKF.

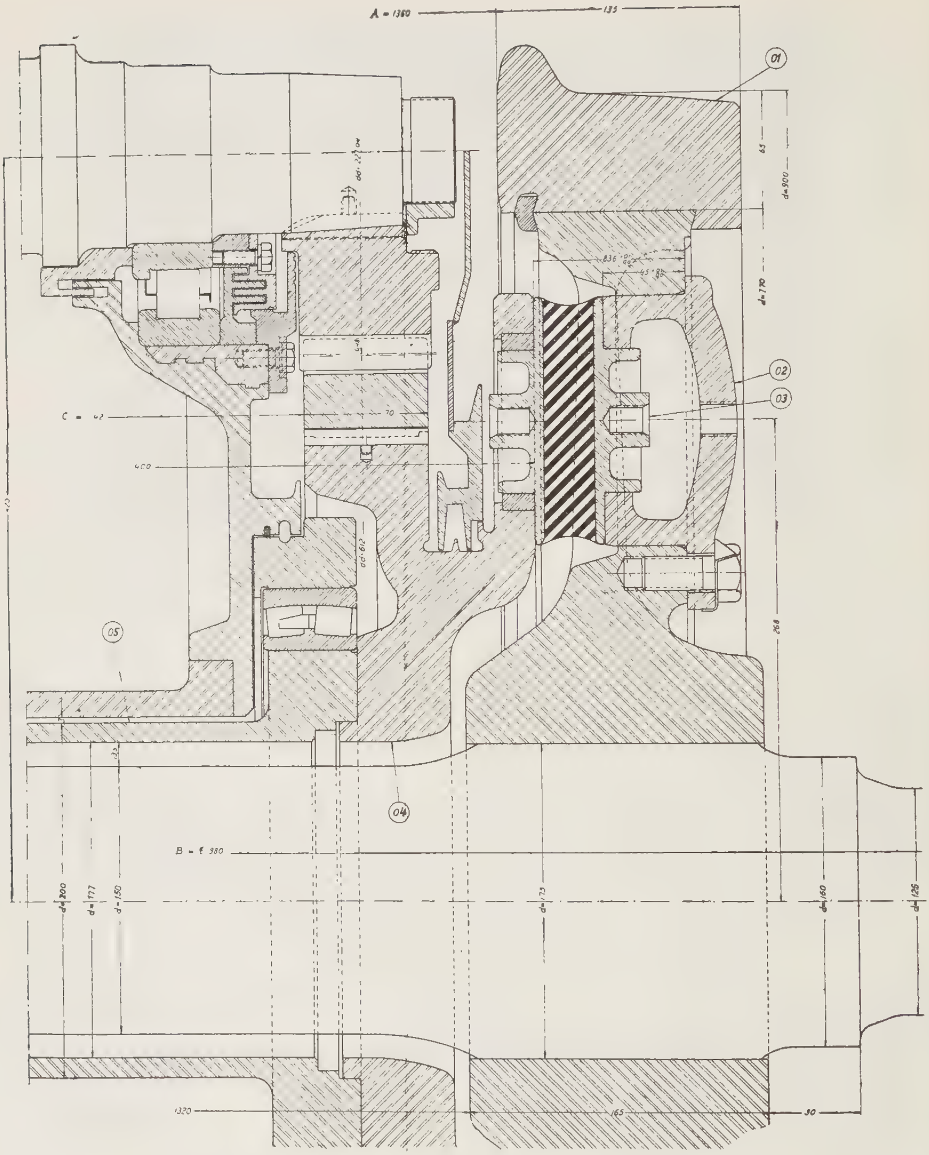
Fig. 334. — Complete driving axle of sets in figs. 331-333, with hollow shaft bearings and SKF roller bearings. The driving mechanism and the gears (with oblique teeth) are bilateral.



Plan ASEA.

Fig. 335. — Vertical section through centre line of driving axle shewn in fig. 334 (railcars, figs. 331 and 332). The hollow shaft, 01, also turns in the roller bearings, 010, as will be seen from fig. 334. Cf. figs. 336 and also 327, for BB locomotives modified :

01 = hollow shaft.
02, 03 = pin for fixing the geared rim against the flange of the hollow shaft.
04 = gear wheel body.
05 = similar to item 010 of fig. 326.
06 = similar to item 02 of fig. 335.
07, 08 = fixing bolt for 06.
010 = SKF roller bearing (cf. fig. 300).

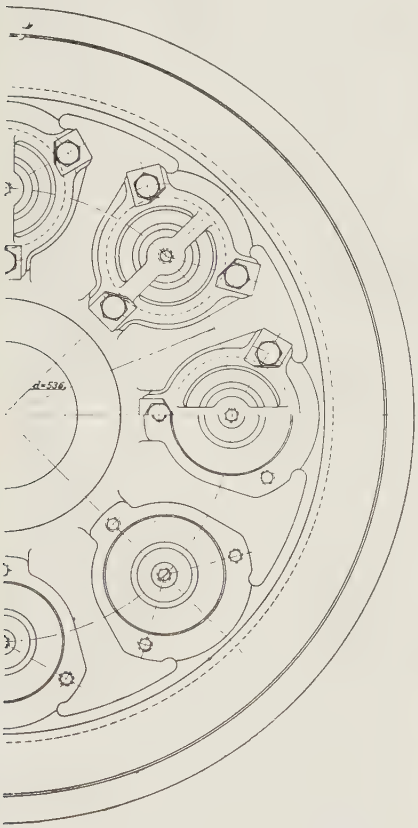


Plan ASEA.

Fig. 336. — Horizontal section of end of driving axle shewn in figs. 334 and 335, shewing the detail of the mechanism as well as — top, left — the end of the traction motor shaft and pinion. The rubber disc, shewn in heavy hatched lines, is vulcanised on the two adjacent retaining plates.

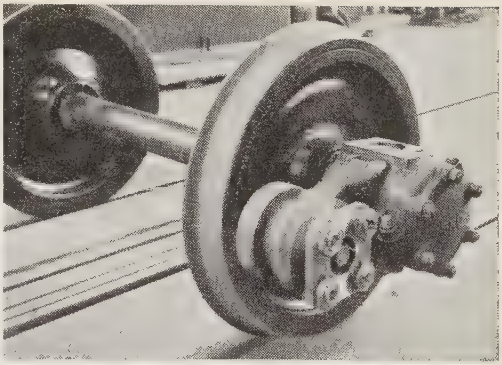
02 = threaded fixing plate for disc. — 03 = see figs. 337 and 335 (06). — 01 = tyre. 04 = body of the cog-wheel. — 05 = hollow shaft.

report on the behaviour in service of this mechanism, since it has only been in service for some six months, i.e. Summer of 1948. During trials at speeds up to 140 km./h. (87 m.p.h.) the behaviour was very good. Fig. 338 shows the suspension arm on a carrying axle.



Plan ASEA.

Fig. 337. — Exterior view of half-wheel, corresponding to figs. 334 to 336; the upper half has the fixing plates in position (02); the lower half is without them.



Cliché SKF.

Fig. 338. — View of carrying axle of sets in figs. 331 and 332 (end and central bogies of these sets). This shews the roller bearing box with the suspension brackets with « silent-blocs » — supported in position for photographing — for the suspension (cf. fig. 333 for driving axle).

One interesting peculiarity of the electrical equipment is worthy of mention : the entire body of the traction motors is cast in aluminium alloy « silumin » (alpax), treated at 350° C. (see fig. 339). This has been used not only for reducing the weight, but also because of the higher cost of cast steel.

Following the new rubber mechanism of the ASEA just described, it will be of interest to record for reference, an

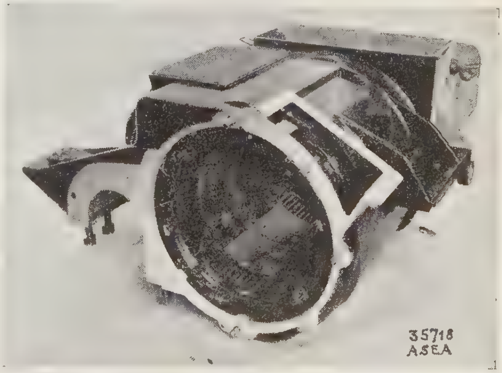
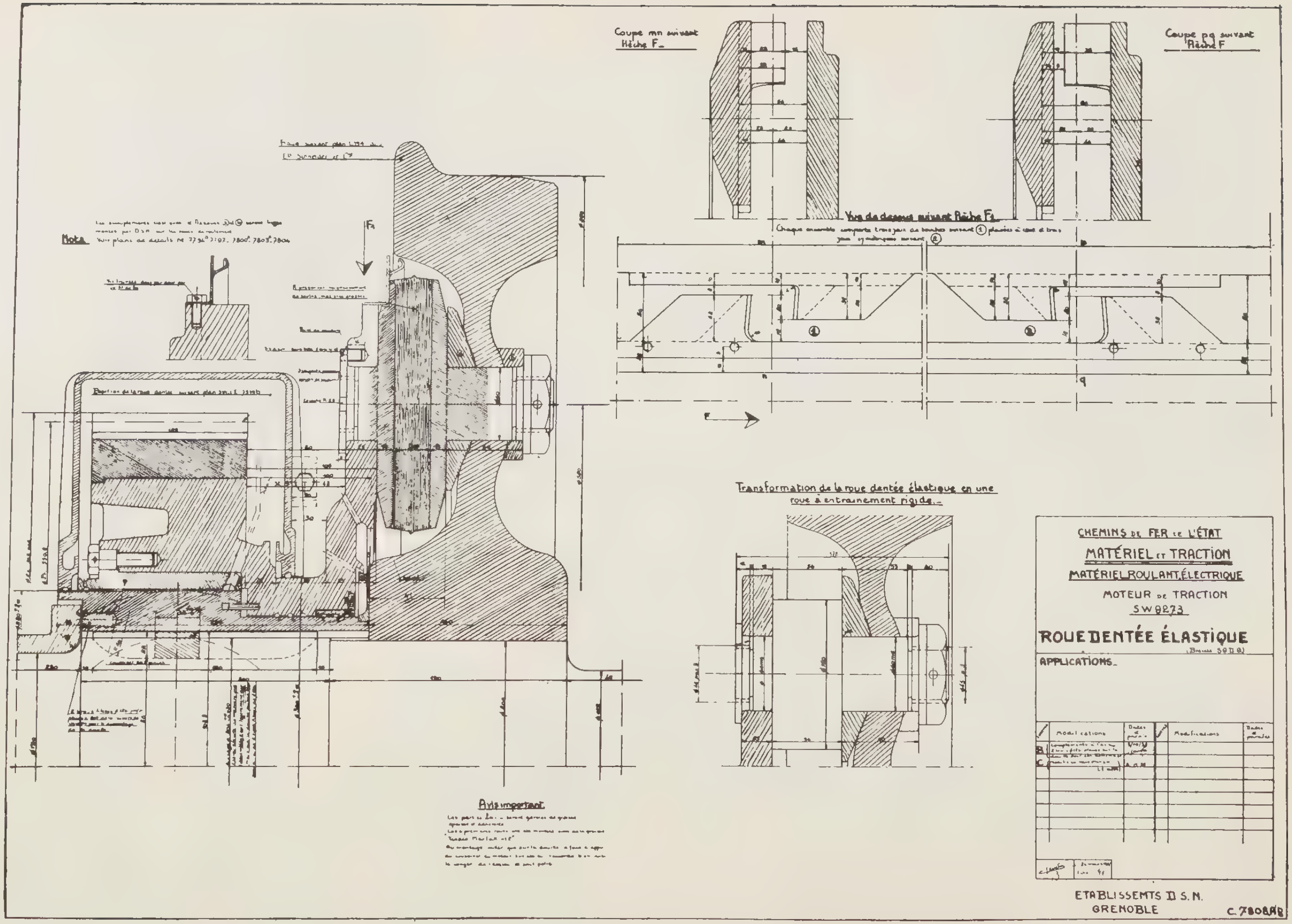


Photo ASEA.

Fig. 339. — Combined body and stator, cast in light alloy (silumin γ or alpax) for traction motors of sets of figs. 331-333.



Plan ETAT (D. S. N.).

Fig. 340. — Rubber disc mechanism, probably the first of its kind, for flexible joint between gear wheel and wheel centre. Fitted in 1938 on double railcars of the 23701-23720 series of the Paris-Le Mans electric line (former Etat, France). Cf. figs. 327 and 336.

earlier similar trial carried out on the *French* West Region (former Ouest-Etat system). This also dealt with a flexible coupling by rubber discs between the gear wheel and the driving wheel centre. Fig. 340 shows this arrangement, which was somewhat inaccurately described as a flexible gear wheel, and which will not be described in detail as the drawing is quite explicit (202).

This mechanism was, towards the end of 1938, fitted on one of the double railcars, Nos. 23701 to 23720, working on the electrified main line Paris-Le Mans. The flexible drive was taken out of service after it had worked a total mileage of 250 000 km. (155 000 miles) under different railcars, during which some defects had shown themselves; unseating of the rubber discs as a result of heating and difficulty of providing efficient protection against oils and grease. This flexible gear wheel, with helicoidal teeth (at an angle of 6° 30'), was lubricated by an oil pump in a light alloy gear case.

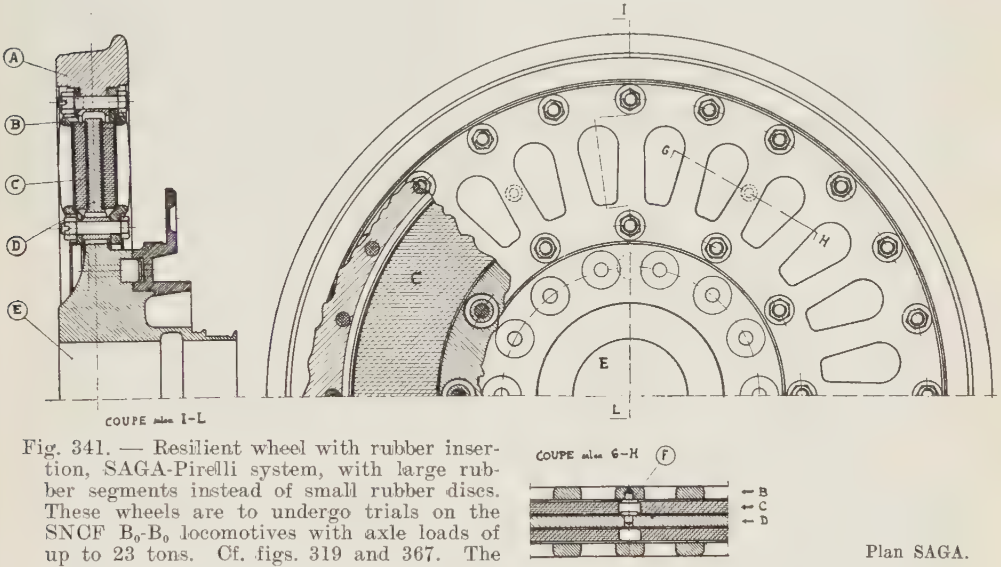


Fig. 341. — Resilient wheel with rubber insertion, SAGA-Pirelli system, with large rubber segments instead of small rubber discs. These wheels are to undergo trials on the SNCF $B_0$-$B_0$ locomotives with axle loads of up to 23 tons. Cf. figs. 319 and 367. The indicating letters are the same as for fig. 319, apart from C, which indicates the segments instead of the discs, and G-H, the ventilation openings.

Whilst on the subject of the SNCF we may refer to fig. 341, which is a plan of the flexible driving wheel which it is intended to fit experimentally to one or two $B_0$-$B_0$ locomotives of the 8001 series, along with an SAB arrangement which is very similar. This has already been described.

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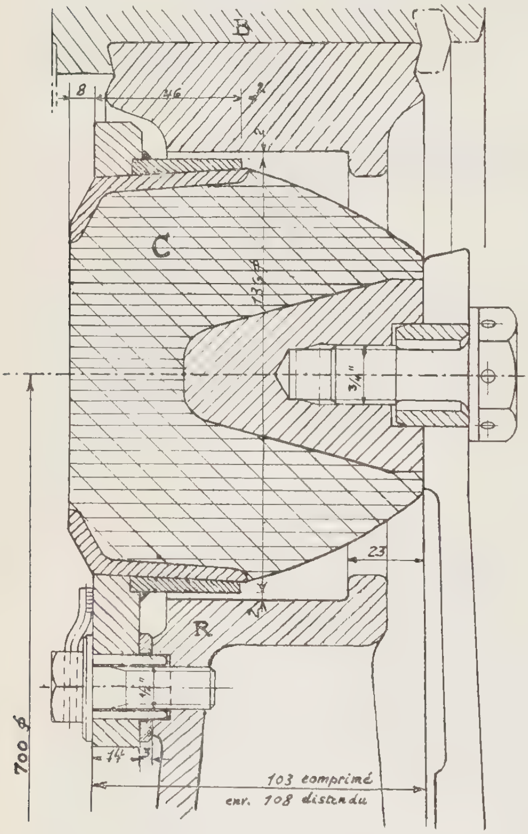
(202) There are in existence gear wheels with rubber pads inlaid between rim and wheel centre. See *Metropolitan-Vickers Gazette*, Manchester, May, 1948, pp. 283-289, 12 figs. « The development of traction gears », A. MIDDLETON. The rubber resilient gear wheels are shown as follows : bottom of p. 287 (obsolete type), p. 288 (tramway type) and 289 (railcar and electric locomotive type). They will be dealt with briefly at the end of this Appendix.

With regard to figs. 197 and 198 and the remarks at the top of the page containing fig. 200, fig. 342 shows one of the « silent-bloc » type rubber units, which will replace the spiral springs, marked E in fig. 197 of the Oerlikon mechanism. This modification refers to *Switzerland,* as also do the following notes.



Plan Oerlikon.

Fig. 342. — Flexible transmission unit in reinforced rubber, Oerlikon mechanism of figs. 197 and 198. These units are being tried on a rail motor brake van Fe 4/4, series 801, ex 18501, of the CFF, in place of helicoidal springs. This figure can be superimposed on the top right-hand corner (C-E) of fig. 197.

C = rubber unit.

B = tyre.

R = wheel centre.

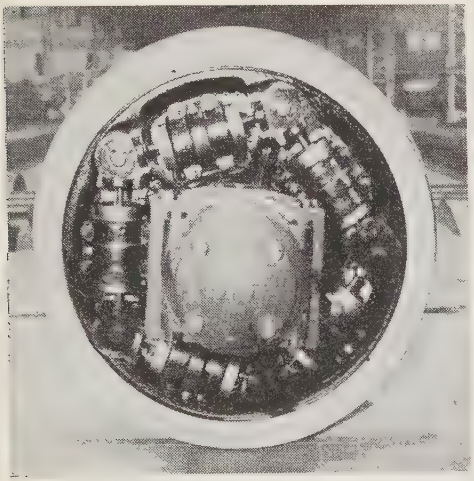
See text on page with fig. 197.

In connection with the *Meyfarth-Secheron* flexible, push rod, mechanism (which might be called also the « Secheron II »), the pages containing figs. 116 (right hand column), 118, 124, 126-140 contain almost everything which can be recorded in this matter. With regard to the locomotives and railcar sets of the Lötschberg line (BLS), it has been stated that the mechanism is, or will be, replaced on locomotives by the Secheron 1 (developed from the quill drive with double spring-housing) which has been used since 1926 on Ae 6/8 locomotives of this series (see figs. 43 and 45); on railcar sets, it will be replaced by an oil-bath spring mechanism similar to that in figs. 146 to 150 which was mentioned below fig. 130 and to the right of fig. 131.

The reasons why the Secheron II has at length been found unsuitable, despite the heavy mileage achieved, for the traffic requirements are in our opinion to be found in the exceptionally heavy service demands made by the mountainous nature of the BLS main line (Thun-Spiez-Lötschberg-Brigue). With a power of 1 500 H.P. per axle, and a resulting couple of up to 2 000 kgrm., the specific compression and decompression become much too high for the push-rods. We have also mentioned, in the case of the *Swedish* (S.J.) the very heavy service conditions, the locomotives being used up to the limit of adhesion; in continuation of figs. 93 and 123, we are including fig. 343, of the end view of an axle with push-rod mechanism and SKF boxes, for the M class, freight locomotives of the Swedish S.J. The excessive degree of decompression from the push rods gave rise to the same consequences in Hungary (MAV) during the war (see page including fig. 129).

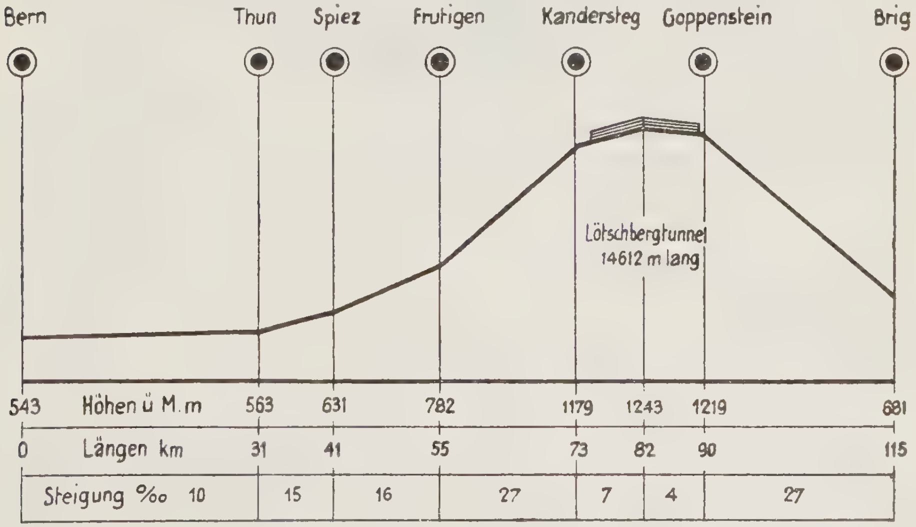
To illustrate the difficult conditions of the Lötschberg line in *Switzerland*, we give in fig. 344 the longitudinal section of the line. Fig. 345 shows locomotive 207 with a heavy train, during the winter, in Kandersteg station, the highest on the line. It is the same locomotive shown in fig. 44.

With regard to railcars of the Berne-Neuchatel line (BN) (and other lines operated by the BLS, the « Berner Dekretsbahnen », GBS, SEZ), fig. 346 also shows a Secheron traction motor of 230 H.P. hourly rating (single phase, as also are those in figs. 130 and 132).



Cliché SKF (ASEA).

Fig. 343. — Driving wheel of M class (Litt.) locomotive, Swedish Railways, for freight traffic, $C_0+C_0$ type, series 604-620, with Meyfarth-Secheron mechanism, push-rods. (Cf. figs. 93, 118, 119 and 123.)



Cliché BLS.

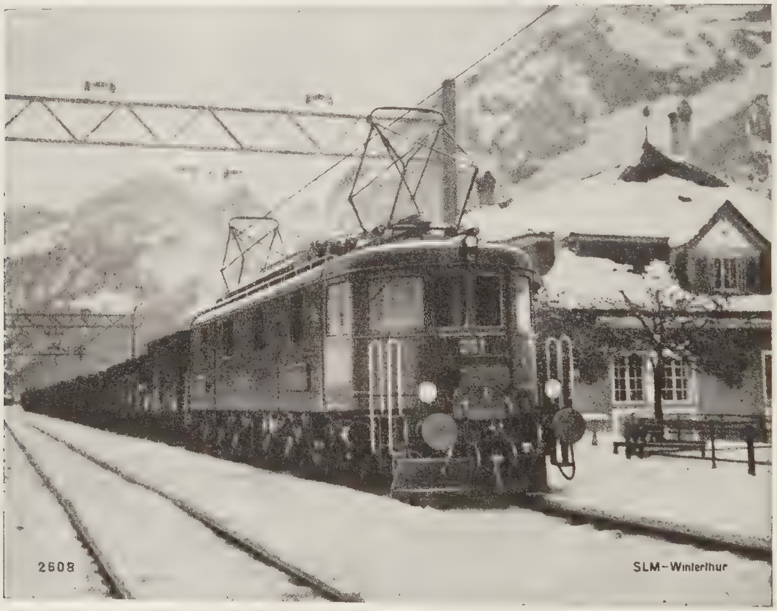
Fig. 344. — Profile of the Lötchberg-Spiez-Brigue line of the Swiss BLS, with long gradients of 27 ‰, numerous tunnels, curves and bridges.

Höhen ü. M. = Heights above sea level. — Längen = Distances. — Steigung = Gradient.

On the subject of the SNCF diesel-electric double locomotive No. 262-AD1-2, type 2-$C_0$-2+2-$C_0$-2, mentioned on the right of figs. 126 and 127 (see figs. 122, 124-126), we are reproducing in fig. 347 another view of this twin engine, which was developed by the « S.A. des Forges et Aciéries de la Marine et d'Homécourt » (France) and built by the companies shown alongside fig. 127.

The error under 2), with reference to the Brown-Boveri transmission through oil-bath springs and crossheads (figs. 146 to 190) alongside fig. 152 and, in particular, the motor unit in figs. 153 and 191, has already been noted. There are two further errors to correct under 10) and 12). These, and some additional notes regarding applications under item 18), are dealt with below:

Under 10). The « Slovak Arrow », class M.290.0 railcar, Nos. 001 and 002, *Czechoslovak State Railways* CSD, shown in figs. 167 to 169, is not fitted with this flexible drive, but has its two electric motors (one per bogie) suspended from the nose, with electro-magnetic transmission of « Sousedik » type, which operates during acceleration or deceleration as an electric transmission and otherwise (when running at speed), as a purely mechanical transmission (²⁰³).



Cliché SLM.

Fig. 345. — Locomotive shewn in figs. 44 and 127, Ae 6/8, 1-$C_0$+$C_0$-1 type, of the Lötschberg BLS (Switzerland), with a train at Kandersteg station (winter service).

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(203) See pp. 3-4 of No. 1-2, 1937, *Economie et Technique des Transports*, Lucerne (published since Jan. 1949, at Zurich, Publishers A. Grob & Cy.). See note (103).

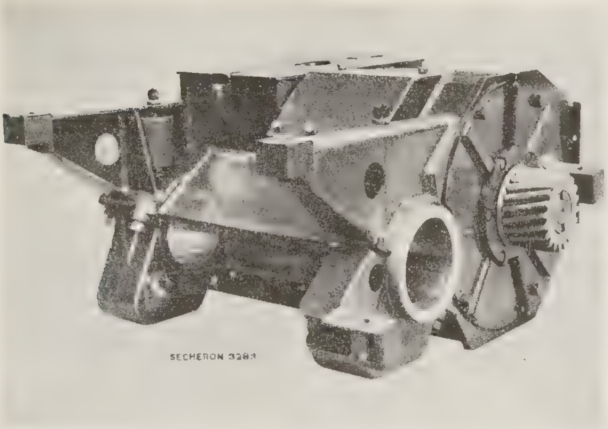


Fig. 346. — Motor of the sets, figs. 129-132, of the Swiss BN (BLS) and Bernese Alps Railways. Welded steel plate body carrying hollow shaft.

Cliché Sécheron.

The two diesel-electric railcars of the Czechoslovak State (CSD) fitted with oil-bath springs, are the M.284 class, Nos. 001 and 002, also 1A-A1 type, ordered in 1938, which were delayed by political events and the war, and were not put into service until 1947.

These cars, designed for a maximum operating speed of 125 km./h. (78 m. p.h.) have an hourly rating, at the tread, of 380 H.P. Each of the bogies of the cars is fitted with 250 H.P. diesel engine, « Büchi » compression type, and, on the inside axle, an electric motor driving the spring mechanism on the end of the hollow shaft. These cars were built by

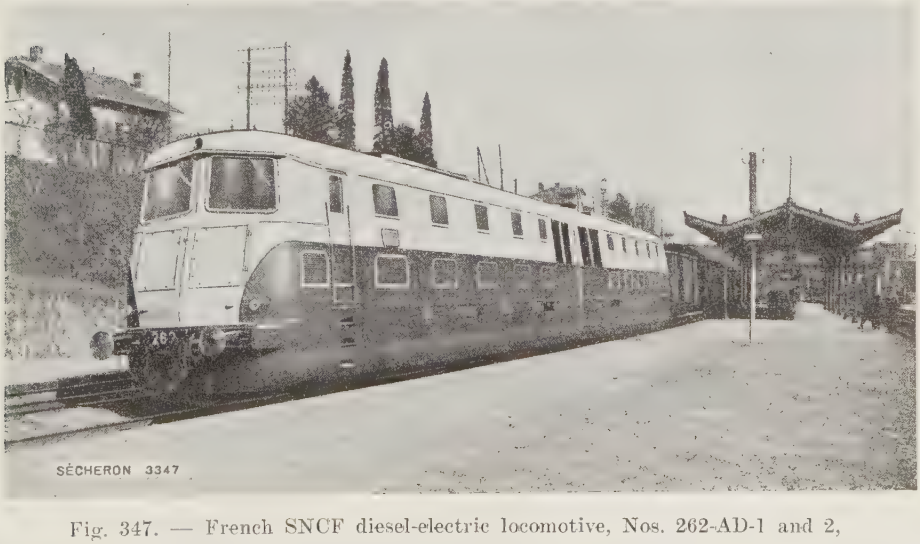


Fig. 347. — French SNCF diesel-electric locomotive, Nos. 262-AD-1 and 2, figs. 124 and 126, with a train in a station.

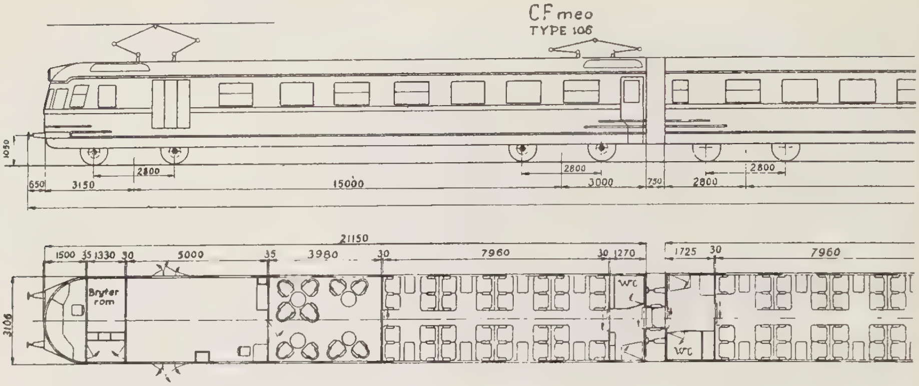
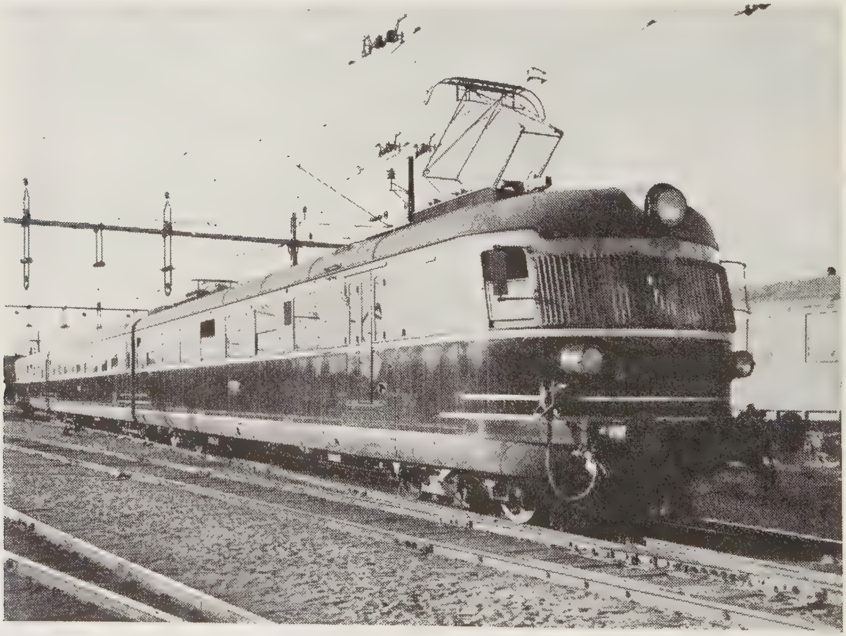
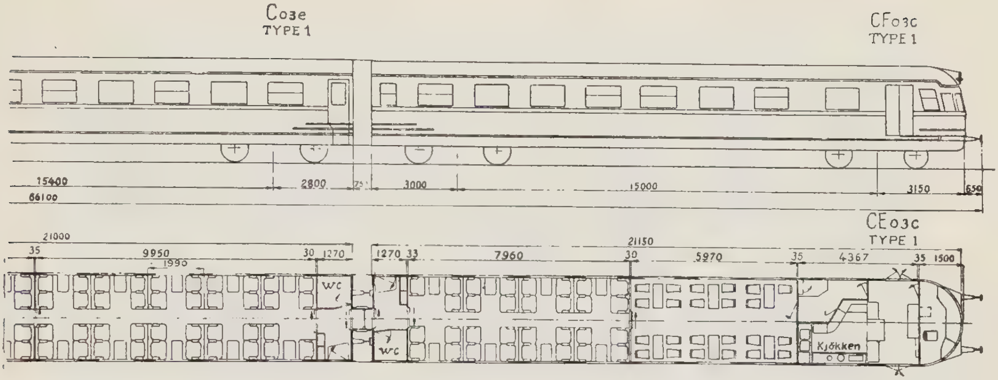


Fig. 348. — Dimensioned plan and elevation of the express electric sets shewn in fig. 173
is coach C Fo 3c in the elevation and coach C Eo 3c in the plan; C Eo 3c having at
compartment instead of the kitchen and vestibule, and the central compartment has the
the leading coach (that on the left hand side of the diagram) is driven (by 4 motors).



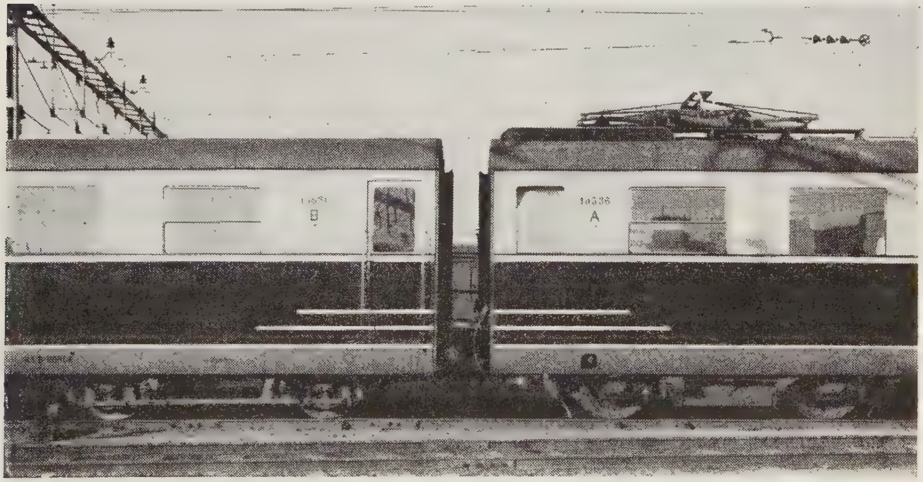
Cliché SKF.

Fig. 349. — Three-quarter front view of the set in figs. 173 and 348 with motor vehicle leading.



Plan NSB.

(Norwegian NSB). The trailing vehicle with driving compartment, shewn on the right, the right hand side the kitchen and dining compartment. In C Fo 3c there is a luggage same seating arrangement as in the next compartment (left hand end of the vehicle). Only



Cliché SKF.

Fig. 350. — View of coupling between motor vehicle and middle trailer of sets in figs. 348 and 349.

the « Kralovo pole — Königsfelder Maschinenfabrik » of Brun (Brno), Moravia, CSR (204).

This error has arisen as a result of the subsequent designation of all the various high-speed railcars as « Slovak Arrows ».

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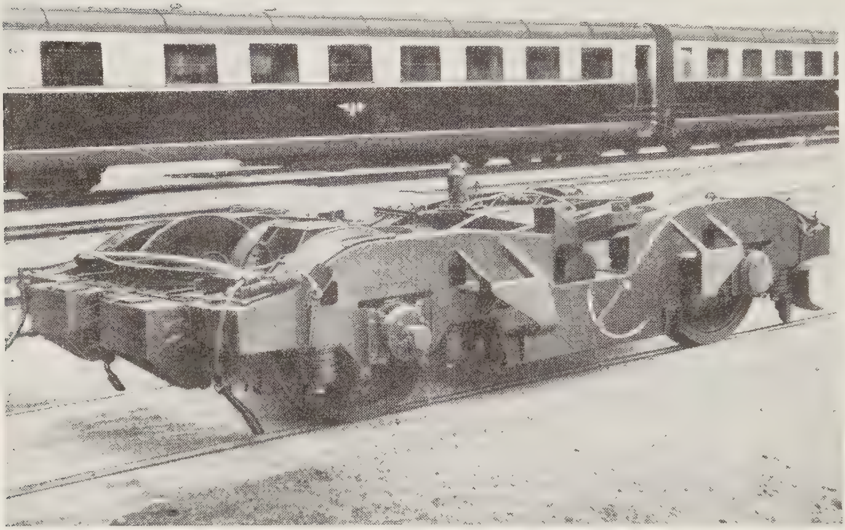
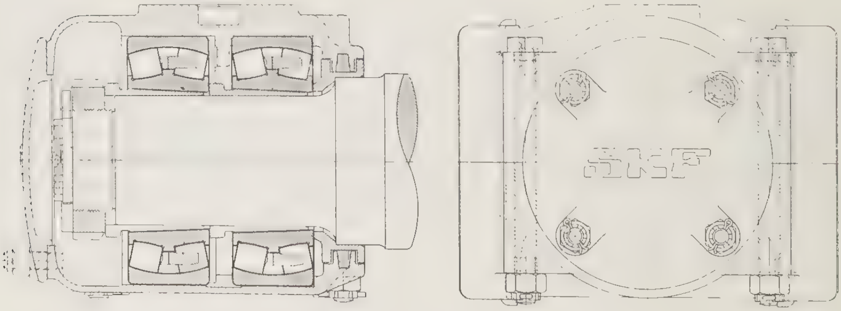
(204. The M.284 series motor vehicles are simply a development of the M.273, the power of the motors having been increased by the Buchli compression. There is an 8-cylinder V engine on each bogie, coupled to a Brown-Boveri generator. The recent cars will have only a single 450 H.P. diesel motor.



Cliché SKF

Fig. 351. — Driving bogie of leading vehicle of figs. 173, 348-350, with Brown Boveri oil-bath spring mechanism (SKF roller bearing axleboxes). In the background are the two trailing vehicles of the set.



Cliché SKF.

Fig. 352. — Section of journal with SKF double roller box and front view of box, bogie of fig. 351.

Under 12). With regard to the *Norwegian* NSB triple railcar sets mentioned at the side of fig. 167, it was erroneously stated in the sub-title to fig. 173, that these were quadruple sets (four coach units) : fig. 173 shows two of these *triplet* sets (3 coach units) coupled together. In addition to fig. 173, figs. 348 to 355 illustrate these cars : a dimensioned sketch of the set comprising a motor coach with 4 driving axles and two trailers which cannot be uncoupled in service; a better view of the set than that in fig. 173, showing it on a larger scale; the coupling arrangement for two units; a view of a driving bogie in front of one of the sets; an SKF axlebox; and, finally, the regulator working from an axlebox, for the compressed air brake. The regulation is effected as follows :

The apparatus, which is intended to avoid the locking of axles comprises a centrifugal governor connected to the axle journal; this governor operates a valve, the movement of which is transmitted hydraulically to another valve mounted on the brake cylinder. The air pressure in this cylinder is thus regulated proportionately to the speed, as the brake cylinder valve allows the escape of more or less air, causing the pressure in the cylinder to rise or fall. In the event of danger, the driver of the locomotive or the set has no decision to make regarding the point at which the brake can be applied, as this can be done

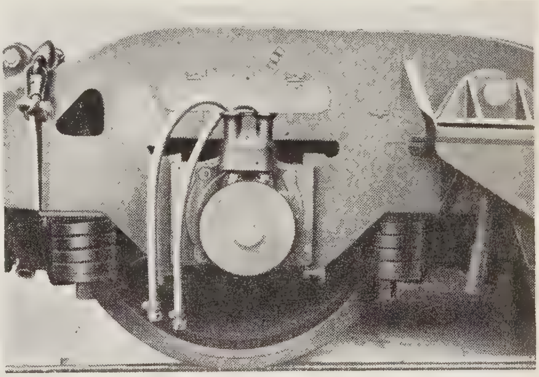


Fig. 353. — Arrangement of governor for compressed air supply to brake on a driving axle of car shewn in figs. 348-351.

Cliché SKF.

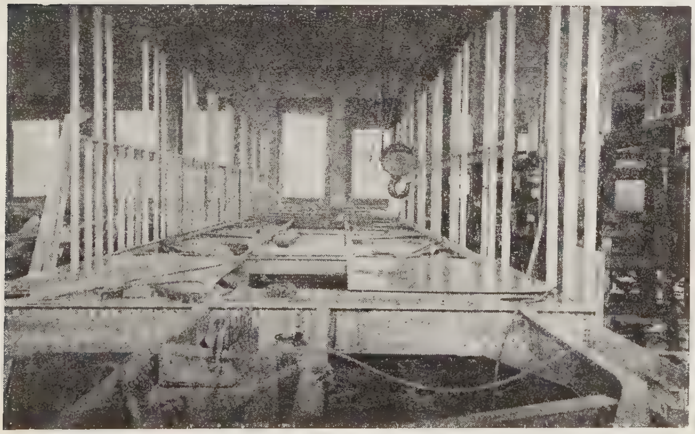


Fig. 354. — Underframe and body skeleton, being erected, made entirely of aluminium alloys; leading coach of sets in figs. 173, 348 and 349. Norwegian NSB.

Photo Nordisk Aluminiumindustri.

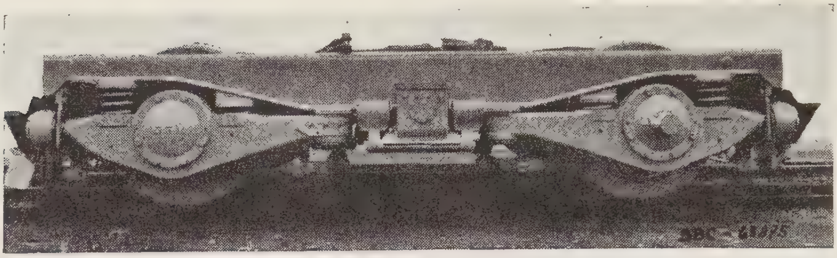
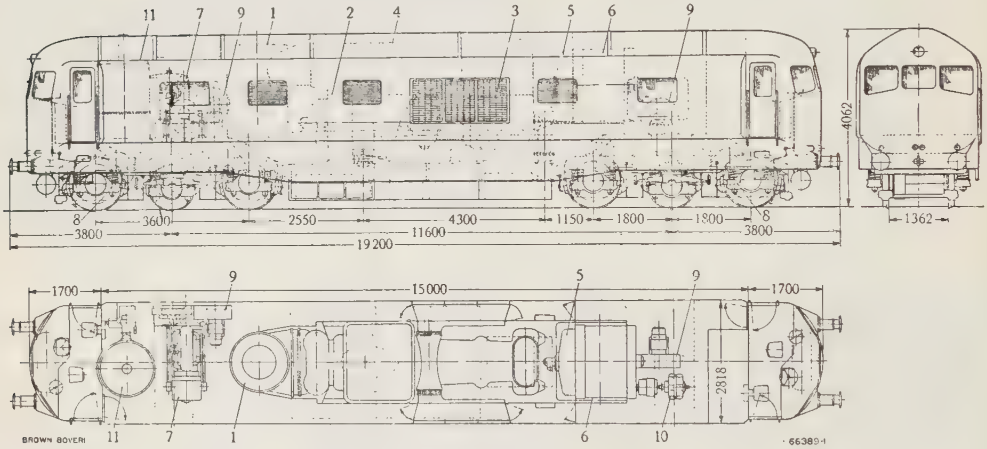


Photo Brown Boveri.

Fig. 355. — Normal gauge driving bogie, shewn in plan and elevation in fig. 183, of GFM (Freibourg, Switzerland) railcars, series 161 (fig. 182).



Plan Brown Boveri.

Fig. 356. — Dimensioned sketch of gas-turbine locomotive with electric transmission, No. 18000, type A1A-A1A, Western Region, British Railways (ex-G.W.R.) (under construction).

immediately and fully. The centrifugal governor then operates automatically to apply the braking force appropriate to the decreasing speed.

It may also be remarked that these sets are constructed in aluminium alloy (205). See fig. 354.

Under 18). In connection with figs. 182 and 183, another view of the bogie shown in fig. 183 of the BCe 4/4 motor vehicles of the Freiburg (GFM) Railway, Switzerland, (206), is given in fig. 355. (See remarks on pages with figs. 184-186).

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(205) See *L'Allégement dans les Transports* (since, *Economie et Technique des Transports*), Lucerne (Zurich), No. 11-12, 1937, pp. 156-157, 3 figs., Dr. K. SUTTER (light rolling stock); also *Aluminium i vognbygging*, vol. of 139 p., 63 figs., calculation and bibliography, A. BRIUCK, Oslo, 1948 (A/S Nordisk Aluminiumindustri).

(206) See note (111) at bottom of page, author's name D. STRAUB †.

It is not yet possible to make a definite statement regarding the behaviour of this new type of bogie.

Regarding the Brown-Boveri oil-bath spring mechanism, the *French* SNCF are considering its possible use on new motor vehicles which are projected but on which no decision has yet been reached.

Finally, there is a new application of the mechanism to report; this is on the gas turbine locomotive with electric transmission, of the Great Western Railway, type A1A-A1A, No. 18000 (series 18000-18100) now absorbed, following nationalisation, in the British Railways as the Western Region.

Fig. 356 shows a dimensioned sketch of the locomotive, which is at present under construction (207). This has already been mentioned in the text below fig. 190. It may be compared (see the text at the side of fig. 167) with the description of the Swiss Am 4/6 locomotive, No. 1101 of the CFF (figs. 170 to 172).

The characteristics of this new English locomotive (standard gauge) are as follows :

| | |
|---|---|
| continuous output from the turbine shaft . . . . | 2 500 H.P. |
| tractive effort at rail at a speed of 103 km./h. (64 m.p.h.) . . | 5 640 kgr. (12 450 lbs.) |
| maximum operating speed . . . | 145 km./h. (90 m.p.h.) |
| maximum weight in running order | 117 tons |

With regard to the *Negri* mechanisms, described on the pages with figs. 200 to 212, everything has already been covered in this Appendix to Chapter IV (see figs. 308 to 310 and pages with figs. 308-315).

*(To be continued.)*

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(207) See *Revue Brown Boveri*, Baden-Suisse, No. 6-7, 1947, p. 144. « First British gas-turbine locomotive », A. E. MÜLLER (in French).

[ 385. (09 (496 + 56) ]

# The Turkish Railways under the Republican Regime,

by M. Zubeyir AKÇADURAK,

Inspector attached to the General Management of the Turkish State Railways and Harbours.

To get an idea of *railway activities* under the Republican regime in Turkey during the last twenty-five years, it is only necessary to compare the two maps of the country given below, one dated 1923, the year the Republic was proclaimed, and the other 1948.

But before we deal with the matter, we think it opportune to clarify this brief report by explaining what we mean by *railway activities*. This expression, as far as our country is concerned, has two aspects, the first of which is characterised by the construction of new lines, and the second by the nationalisation of those already in existence. To these we might add a third, represented by the importance and care taken to develop and intensify international relations, in other words the through international services to or through our country.

The examination mentioned above shows that on the 1923 *map of Turkey* the railway stopped at Ankara in Central Anatolia; on the other hand it was more developed in the southern and western parts of the country, for political and commercial reasons, as well as owing to the fertility of these regions, and ran from Eskisehir via Afyon, a junction, to Konya, Yenice, Adana, Fevzipasa and after running through part of Syria between Islahiye and Çobanbey, the two frontier intersections, to Mardin and Nusaybin.

Izmir was linked up with Afyon on the one hand through Manisa, and with Istanbul on the other by the port of Bandirma on the Marmara.

Adana was linked up with Mersin, a Mediterranean port, by Yenice and Istanbul to the rest of the Continent of Europe by Uzunköprü and Edirne. The Dörtyol-Iskenderun section completed the link with Adana.

The Izmir (Alsancak)-Aydin line was still a dead end, and the wide and narrow gauge line from Erzurum to Sarikamis and Arpacay (on the Russo-Turkish frontier) was a local railway, quite separate from the rest of the country.

On the other hand, the districts of Kayseri, Sivas, Erzurum, Elazig, Malatya and Diyaribakir, fruitful agricultural and mining regions and the ports like Samsun and Zonguldak (the port of the coal basin) on the Black Sea had no connection with the railway.

This can be taken as being at once the sum and expression of the railway activities of the past, which in spite of several attempts, had not been able to develop any solid programme and well defined plans for a national railway. An examination and analysis of the financial, political and commercial reasons responsible for

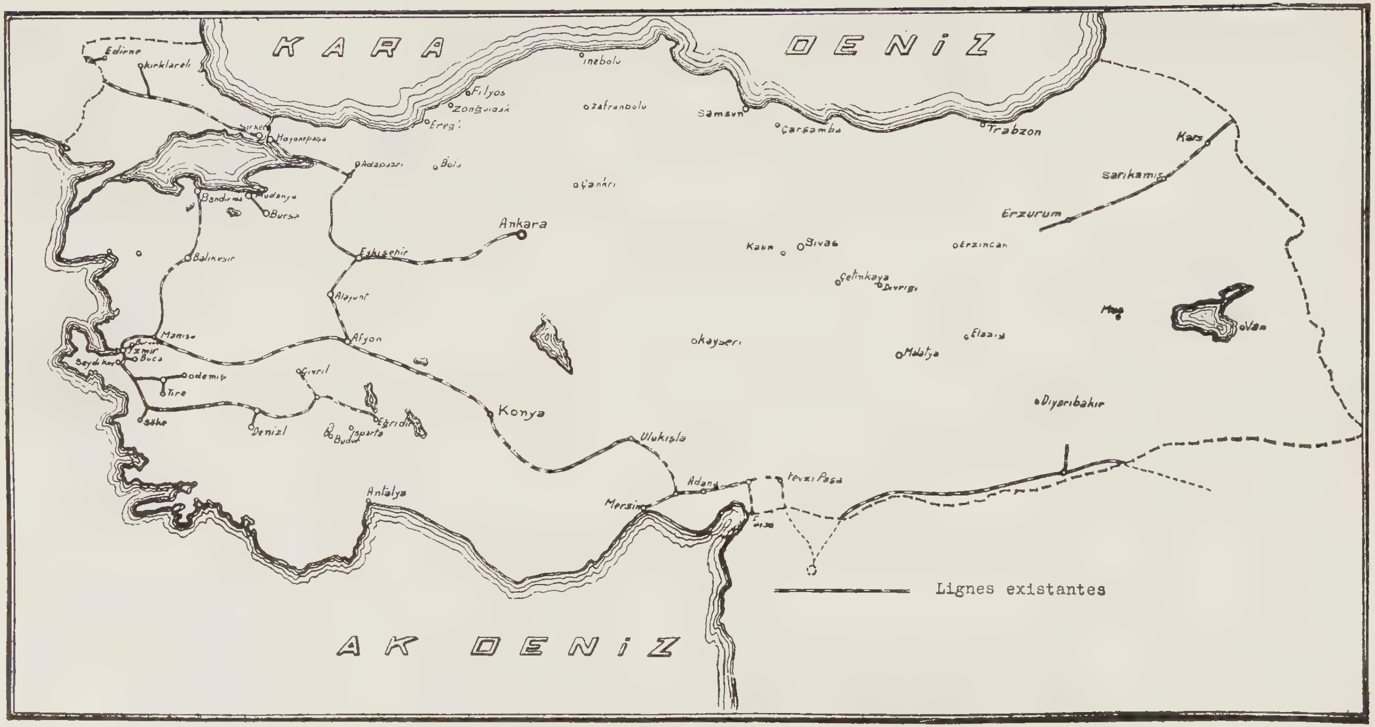

Fig. 1. — Map of the Turkish Railways in 1923.

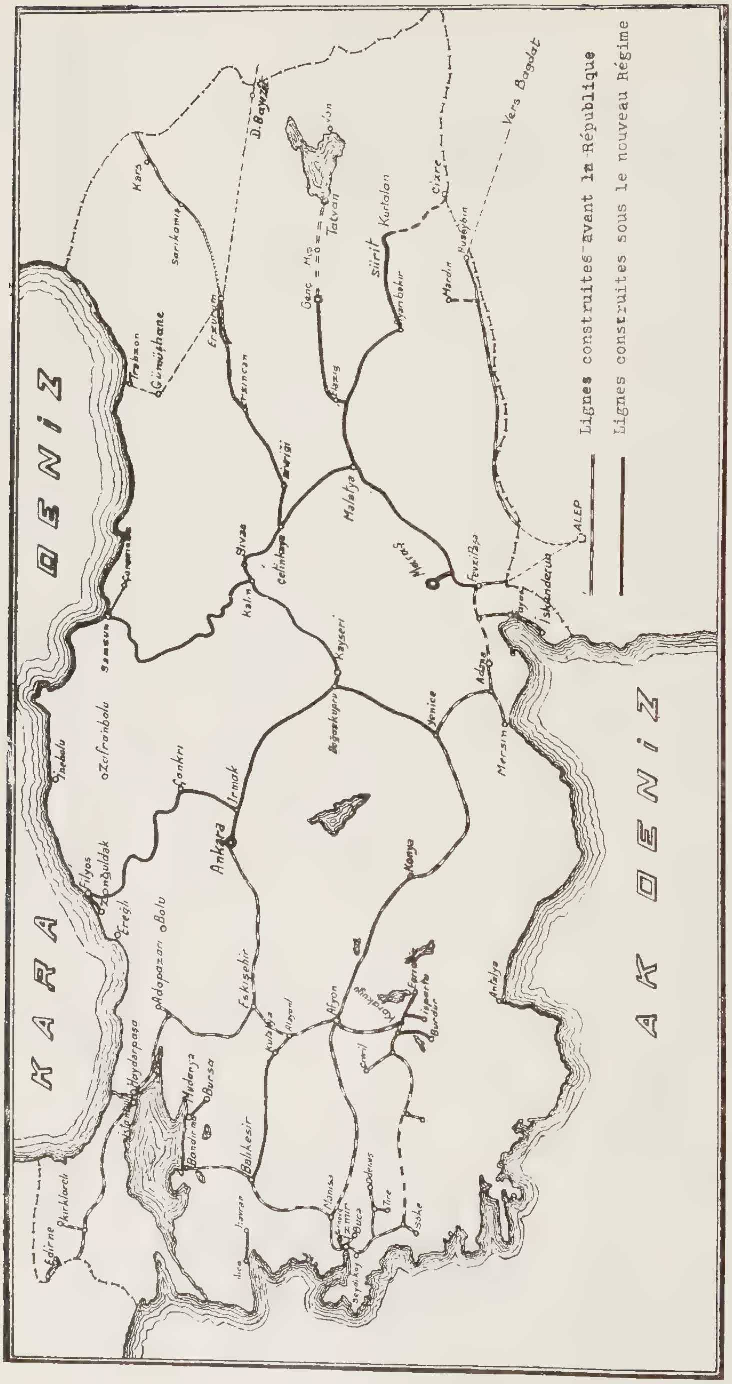

Fig. 2. — Map of the Turkish Railways in 1948.

— — — — Lines built before the Republic was set up.

———— Lines built under the new regime.

this lack lie outside the scope of our report. It is however useful to point out here that a similar situation was the reason for the dispersion of certain important lines later on, which now are included in the frontiers of various Arab and Balkan States.

In Turkey, the beginning of the construction of railway lines, within the present frontiers of our country, dates back to 1856, the first concession, that of the Izmir-Aydin line having been granted by the Firman on the 23rd September 1856.

As in certain European countries, in Turkey also foreign capital contributed to a large extent to the construction of the Railway.

When the Republic was proclaimed, the patrimony of the past consisted of :

| | | | |
|---|---|---|---|
| the Anatolia-Bagdad line . . . . . . . . . . | N | 2 064 km. | (1 283 miles) |
| the Izmir-Aydin line . . . . . . . . . . . . | N | 609 km. | ( 378 miles) |
| the Izmir-Kasaba line & extensions . . . . | N | 703 km. | ( 437 miles) |
| the line from Thrace . . . . . . . . . . . . | N | 336 km. | ( 209 miles) |
| the line from Mudanya-Bursa . . . . . . . . | E | 41 km. | ( 25 miles) |
| the Ilica-Palamutluk line . . . . . . . . . . | E | 29 km. | ( 18 miles) |
| the Erzurum-Sarikamis line . . . . . . . . . | E | 232 km. | ( 144 miles) (*) |
| the Sarikamis-Arpacayi line . . . . . . . . . | L | 123 km. | ( 76 miles) |
| Total. . | | 4 137 km.<br>of lines | (2 570 miles) |

With the exception of the Anadolu-Bagdad, Mersin-Yenice and Erzurum-Arpaçayi lines, the remainder of the above mentioned lines were operated by different concession holders, and were bought up by the State in their entirety.

The conception and political economy of the new Regime differed in every way and on all points from that of the past. Communications were at the basis of this policy and the railways occupied a very preponderant part. They were considered, in view of their transport capacity and the vast extent of the country, not merely as a simple means of locomotion, but as one of the principal factors in the national recovery.

Another very characteristic feature of this conception resulted from the clauses and stipulations of the protocol as well as the supplementary declarations of the Treaty of Lausanne of the 24th July 1923, according to which the young State, whilst recognising their validity, did not hesitate to accept the obligations and impositions of the concessions and agreements made in Empire days and consequently prior to its constitution. As a result there was nothing equivocal in the line of conduct adopted by the Turkish Republic.

The harsh lessons, learnt from the experiences of the past as well as the sufferings endured by the country during the successive wars and its impoverishment due to the disastrous and devastating consequences thereof, had indeed borne fruit.

In support of this new policy, we may quote from the different speeches of

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(*) *Note.* — The length was afterwards reduced to 174 km. (108 miles.)

Atatürk and Inönü, the two Republican Leaders of our country, the following passages :

« The activity and strength of the economic life are proportional to the extent and situation of the methods of communication, the railways, and the ports. » KEMAL ATATÜRK.

« For the National Government the need for railways is a question of national union, national necessity and national policy. It is the problem of the conservation and defence of the national Independence, the work of several centuries. » ISMET INÖNÜ.

It was these considerations that were at the basis of railway activity in modern Turkey, which now has a system of some 7 697 km. (4 782 miles).

The whole of this system is operated by the State. A *road system of some 642 km. (398 miles)* has just been added to it, also managed by the State, from Trabzon, a port on the Black Sea, to the frontier of Iran, known as the « Iran Transit Road ».

Whilst this national railway system was being achieved, there was a continuous expansion from the centre outwards. The existence of a railway as far as Ankara, the capital of the new State, considerably facilitated the concentration of efforts in the Eastern and South-Eastern regions.

This time, native capital was used for the construction of the new lines, as well as to buy up the old lines.

As for the schedule of the new Regime, this was as follows :

| SECTIONS | Gauge of lines | | | | |
|---|---|---|---|---|---|
| | Standard | Narrow | Wide | Total | |
| | | | | (km.) | miles |
| Conceded to the State, by contract . . . | — | 174 | 123 | 297 | 185 |
| Bought up by the State . . . . . . . . | 3 732 | 109 | — | 3 841 | 2 386 |
| Built by the State . . . . . . . . . . . | 3 559 | — | — | 3 559 | 2 210 |
| | | | | 7 697 | 4 781 |
| Road service operated by the State Railways . . . . . . . . . . . . . . . . . | | | | 642 | 399 |
| Total. . . | | | | 8 339 | 5 180 |

As stated above, and as this table shows, the railway policy of the State was not merely limited to building new lines and extending the system, but also proposed to group the different sections managed by various Companies into a single State system. This was altogether essential, both from the point of view of standard rates and standard operating conditions, to be the better able to serve the interests of the national economy.

These necessities led to the birth of the « General Management of the State Railways and Harbours ». This was set up by law No. 1042 of the 31st May 1927. The harbours in question are those ports or parts of ports linked up with the railway. There is also a distinct department, the Ports Administration.

As the history of the Turkish Railways will show, the honour and title of « Founder of the National Railway System » undoubtedly is the prerogative of President Ismet Inönü, who since taking office has always reserved the most important role in this field for himself. The problem of the railways was one of the fundamental questions affecting the country, on which he concentrated the whole of his attention and the whole of his activity.

Up to the present the Republic has built some 3 559 km. (2 210 miles) of lines. As the country extends to some 776 000 km$^2$ there is only 1 km. of line for each 100 km$^2$ or 10 m. of line per km$^2$.

What does this imply compared with countries where there is 3 km. of line per km$^2$ of area?

The following quotation explains the matter :

> « The railways which we have built are the result of the imperious and unavoidable necessities of the national unity, national defence and national independence, none of which can stand even a single day's delay. »
> Ismet Inönü.

The following data are a proof of this thesis.

In our 7 697 km. system, there are *longitudinal* lines such as :

| | |
|---|---|
| Edirne-Erzurum . . . . . . . . . . | 2.062 km. (1 280 miles) |
| Bandirma-Afyon-Kurtalan . . . . . . | 1 906 km. (1 184 miles) |
| Izmir (Basmahane)-Erzurum . . . . . | 1 884 km. (1 170 miles) |
| Istanbul - Afyon - Nissibine (excluding the Syrian section) . . . . . . . . | 1 676 km. (1 041 miles) |
| Izmir-Karakuyu-Malatya-Genç . . . . | 1 715 km. (1 065 miles) |

and *transversal* lines, such as :

| | |
|---|---|
| Samsun-Sivas-Malatya-Iskenderun . . | 1 029 km. (639 miles) |
| Zonguldak-Bogazkopru-Mersin . . . | 1 040 km. (646 miles) |
| Mersin-Erzurum . . . . . . . . . . | 1 035 km. (643 miles) |

To bring out the full value of these figures, it will suffice to recall that before the war the longest distances between two points of transit were :

| | |
|---|---|
| in Germany . . . . . . . . . . . . . | 1 572 km. (976 miles) |
| Austria . . . . . . . . . . . . . . | 888 km. (551 miles) |
| Belgium . . . . . . . . . . . . . . | 359 km. (212 miles) |
| Bulgaria . . . . . . . . . . . . . | 695 km. (432 miles) |
| France . . . . . . . . . . . . . . | 1 396 km. (887 miles) |
| Greece . . . . . . . . . . . . . . | 703 km. (437 miles) |
| Hungary . . . . . . . . . . . . . | 659 km. (409 miles) |
| Poland . . . . . . . . . . . . . . | 1 161 km. (721 miles) |
| Rumania . . . . . . . . . . . . . | 1 041 km. (647 miles) |
| Czechoslovakia . . . . . . . . . . | 1 041 km. (647 miles) |
| Jugoslavia . . . . . . . . . . . . | 1 297 km. (806 miles) |

As the above information shows, the Turkish Railway system, although small compared with the area of the country, is of relatively great importance owing to the national as well as the international services for which it is responsible. This importance is obvious when it is remembered that these lines after linking the frontiers of the country together, carry the products from the Eastern and Southern regions to the large consuming centres in the central and western regions, and link up the Continents of Europe, Asia and Africa.

The cost of achieving this totalled 496 784 979 Turkish pounds by the end of 1947, which is another proof of the importance the new Regime attaches to its railway policy.

* * *

During the second world war in particular the justice of the opinions and the clairvoyance which led to the establishment of this railway system and predetermined its role were manifestly justified.

When the railways had a practically complete monopoly of transport in the country owing to the almost total stoppage of the coasting trade and of road transport on account of the war, they were able to fulfil the role expected of them. During the darkest and most uncertain hours of the war, by making a supreme effort, they were able to provide for all the requirements of the country's markets as well as the imperious needs of the national defences.

In this connection it is interesting to glance briefly at the financial policy of the State.

TABLE I.

| | | 1923 | 1928 | 1933 | 1938 | 1940 | 1943 | 1947 |
|---|---|---|---|---|---|---|---|---|
| *Length of lines* | *Standard gauge* | 1 700 | 2 004 | 3 336 | 6 336 | 6 569 | 6 551 | 6 836 |
| | *Narrow gauge* | 232 | 232 | 309 | 255 | 255 | 283 | 283 |
| | *Wide gauge* | 123 | 123 | 123 | 123 | 123 | 123 | 123 |
| | *Total* | 2 055 | 2 359 | 3 768 | 6 714 | 6 947 | 6 957 | 7 242 |
| *Train/Km.* | | 1 427 305 | 4 067 148 | 5 482 734 | 15 124 301 | 17 402 196 | 21 075 671 | 22 465 673 |
| *Passenger/Km.* | | 172 744 206 | 300 143 047 | 319 801 650 | 2 672 834 247 | 2 942 534 920 | 2 667 591 560 | 2 679 961 300 |
| *Gross tonnes/Km.* | | 521 544 000 | 1 256 398 467 | 1 814 095 047 | 5 484 678 360 | 6 455 261 665 | 8 274 707 130 | 9 038 744 950 |
| *Useful tonnes/Km.* | | 166 893 806 | 237 828 508 | 361 664 926 | 1 296 982 924 | 1 564 493 431 | 2 127 156 278 | 2 352 506 784 |
| *Average journey per passenger* | | 133 | 61 | 61 | 50.6 | 55.7 | 127 | 119.8 |
| *Average journey per ton* | | 533 | 267 | 253 | 303.3 | 292.9 | 321 | 338.9 |
| *Operating coefficient* | | 94 | 73 | 73 | 78 | 70 | 75 | 88 |
| *Cost per passenger/Km.* Piastres | | — | 1.48 | 1.55 | 1.30 | 0.76 | 1.18 | 2.06 |
| *Cost per useful tonne/Km.* | | — | 2.51 | 1.65 | 1.93 | 1.85 | 3.31 | 4.53 |
| *Cost of building new lines* | | 8 700 000 | 161 400 000 | 260 800 000 | 368 500 000 | 394 100 000 | 442 014 000 | 496 784 979 |

At the end of 1946, the balance sheet of the State Railways showed a capital investment of nearly one thousand millions Turkish pounds. At the present time no interest is charged on this enormous capital investment. This national asset is at the disposal of the country merely on payment of a sum intended to cover the operating costs alone. Going as far as possible in this direction, the State guarantees any deficits in the receipts.

In view of the above report, it might be asked whether the development of this railway system, which is sparse in comparison with the extent of the country, but very important owing to its characteristics and the services it renders and the relations it assures, should not be planned to follow a faster cadence?

Indeed yes, if the second world war had not occurred. But like certain other countries, Turkey also had need to turn to foreign products to meet all her requirements. This circumstance however has had a fortunate consequence in the sense that it led the State to revise its railway plans in the light of the experience and results obtained during the war. This led to the programme for an important road system.

Rail/road competition has not yet had the final word, and the present tendency is to consider the railway as essential and the road as a supplement thereto, so it would not be premature to consider that the railway system will still have a considerable development in Turkey.

The information given above is only a brief review of the activity displayed in Turkey, both as regards the construction and operation of railway lines. As far as the results obtained are concerned, these are tabulated in Table I, page 818.

This brief report would not be complete if we did not stress the importance of the Turkish railways from the point of view of the international services which they assure and are destined to assure in the future.

Owing to her geographical situation, Turkey situated at the crossways of the Continents of Europe, Africa and Asia like the keystone of an arch, for centuries has been the thoroughfare between these three Continents and their connecting link. The historical importance of the country due to the age old caravan routes, has in no way been lessened by the construction of the railways, but on the contrary has greatly increased thereby.

If there had been no second world war, the London-Bagdad-Bassorah-India, and Stockholm-Bagdad-Teheran lines, both passing through Turkey, would now be a concrete reality. The Taurus Express, which is the continuation of the Simplon-Orient Express and the Orient Express are going to be continued on to Cairo as soon as the situation in Palestine improves, as well as to Teheran when the Trans-iranian line is completed.

In order to enable it to continue to play its historical and geographical role, this Railway also only awaits the re-establishment of peace and order in the world and proper understanding between the Nations.

[ **621** .138 .1 (44) & **725** .33 (44) ]

# The French National Railways new locomotive sheds. The Avignon depot roundhouse (Vaucluse),

by Paul CALFAS,

Ingénieur des Arts et Manufactures.

*(Génie Civil, 1st may 1948.)*

During the war, and during the operations which took place prior to the Liberation, the French railways, as is well known, suffered considerable damage to the permanent way, rolling stock, structures and buildings (1). Amongst the buildings destroyed were many locomotive sheds, and their rapid reconstruction was essential to shelter the engines as the stock of locomotives was replenished. On the French National Railways as a whole the area of locomotive sheds that was destroyed reached approximately 250 000 m$^2$ (299 000 sq. yards).

The extent of the work necessary in the case of these buildings justified a thorough study being made which would lead to the adoption of a standard type of building, which would be an advantage from the point of view of technical utilisation, economy and rapidity of construction. This investigation was carried out under the guidance of Mr. Robert Lévi, by the Buildings Department of the S. N. C. F. the head of which is Mr. P. Peirani, architect, former pupil of the Polytechnique School, in collaboration with the Institut d'Etudes Techniques (Mr. Bernard Lafaille); as a result a prototype was evolved, the first realisation of which is the roundhouse at Avignon (fig. 1). Before describing it, we will sum up the principles which led to the type adopted, being fixed upon.

## General conception.

The locomotive sheds must:

shelter the locomotives from bad weather;

enable the engines to be moved easily;

make the best possible use of daylight;

assure proper evacuation of the smoke.

The circular layout was adopted in the last century; since then a few rectangular sheds have been built, especially in the period between the two wars, but this layout, which is architecturally easier and can more easily be linked up with the other buildings in a depot, has the drawback of making it necessary to do a lot of complicated shunting, as well as to use traversers, which are costly and complicated. Consequently we went back to the circular layout with radiating lines, served by a single turn-table, which can be depended upon and is relatively cheap.

The circular layout also gives the best lighting; the outer walls can be glazed, and these are further away from the zone in which smoke is produced.

In the old designs, the smoke was usually evacuated directly by means of special devices in the roof, combined with the system of lighting, for example glazed roof lights. However, this latter solution, though more simple, had some drawbacks; in particular the glazed surfaces were soon encrusted with soot. Then too, the smoke is very corrosive; it is therefore an advantage if it can be trapped as close to the locomotives as possible in hoods of appropriate form and evacuated well above the roof.

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(1) See in this connection the *Génie Civil* of the 1st and 15th April 1945.

For the latest buildings therefore a circular layout has been adopted completely roofed in, with no glazing except in the outer walls. The normal type of roundhouse has an outside radius of 66.70 m. (218′ 10″) and an inside radius of 36.45 m. (119′ 7″).

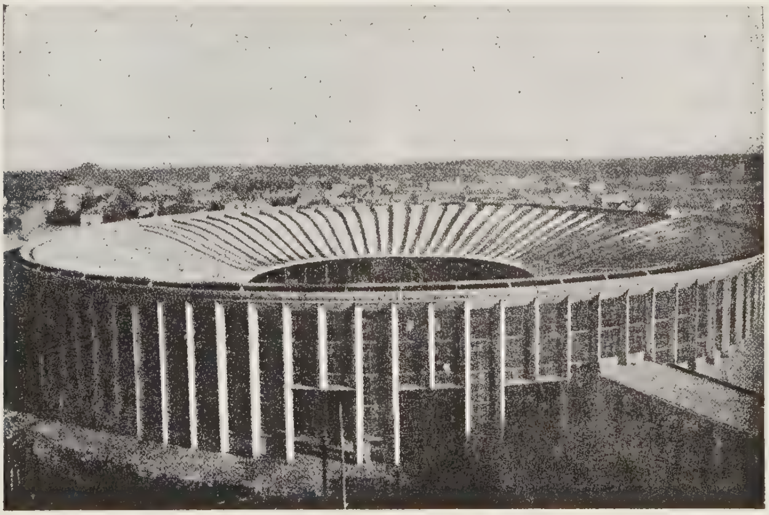

Fig. 1. — The new locomotive sheds of the S. N. C. F. General view of the Avignon roundhouse.

The pit under each track is 25 m. (82′) long; the maximum space taken up by the outer wall is 0.65 m. (2′ 1 5/8″) and that of the inner wall 0.60 m. (1′ 11 5/8″). The width of the inside posts is 0.35 m. (1′ 1 3/4″) and the available space between them 4.50 m. (14′ 9 1/4″). The width of the inside pathways is 1 m. (3′ 3 3/8″) at the turntable side and 3 m. (9′ 10 1/8″) at the periphery.

With this layout the number of tracks radiating from the turntable would be 48. At Avignon, in the layout described below, the site available, in particular the proximity of the national road from Paris to Antibes, made it necessary to adopt an outside radius of 53.75 m. (376′ 3 1/8″) and an inside radius of 22.90 m. (75′ 1 5/8″) which limited the number of tracks to 36 (fig. 2). The useful width of the covered-over ring is therefore 30.25 m. (99′ 2″) in the first case and 30.85 m. (101′ 2 5/8″) in the second. The installation of the travelling crane intended to facilitate carrying out repairs in the shed made it necessary to increase the height of the building. The roof slopes towards the interior, so the outside wall appears very high, and this also makes for efficient lighting (fig. 1).

After comparing the possible constructional materials : ordinary masonry, wood, metal framework, reinforced concrete, or a combination of such materials, reinforced concrete was finally chosen, with prefabrication of the main parts. This solution has the advantages of length of life, resistance to corrosion and bad weather, together with economy and rapidity of execution. Elements of secondary importance have been reduced as much as possible.

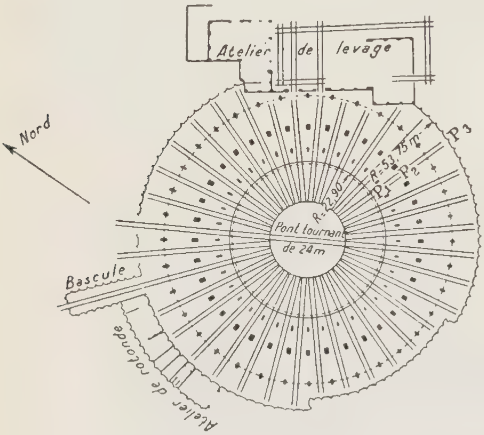

Fig. 2. — General plan of the Avignon roundhouse.

*Explanation of French terms* :

Atelier de levage = Lifting shop. — Bascule = Weighbridge. — Atelier de rotonde = Workshop. — Pont tournant = Turntable.

*Framework of the building.* — The architect has been led to give at the cross section through a radius of the building the arrangement in two spans; the centre span is the lowest and is about 10 m. (32′ 9 3/4″) long; the slope of the roof is rectilinear; the outer span is about 19 m. (62′ 4″) long and is an inclined parabolic arch with unkeyed springs, one side of which is connected to the central span (fig. 3).

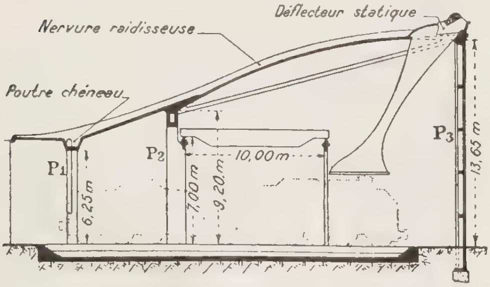

Fig. 3. — Part section of the roundhouse along the centre of a track.

*Explanation of French terms* :

Nervure raidisseuse = Stiffening rib. — Déflecteur statique = Static deflector. — Poutre chéneau = Girder with gutter.

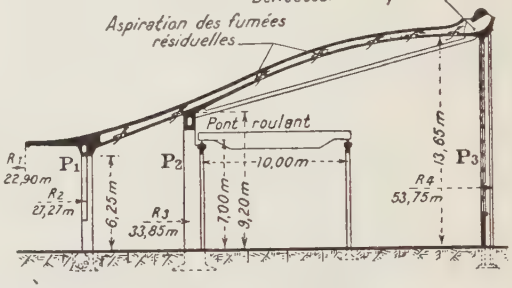

Fig. 4. — Part section of the roundhouse between two tracks.

*Explanation of French terms* :

Aspiration des fumées résiduelles = Extraction of the residual smoke. — Déflecteur statique = Static deflector. — Pont roulant = Travelling crane.

The coping above the outside wall thus becomes a zone of deep depression which favours the evacuation of smoke in the direction of all winds, and consequently the smoke should be evacuated over this coping.

The pillars forming the framework of the outer wall are large V section piers (fig. 5), as this section has the advantage of having a large moment of inertia with a small volume. A similar profile was adopted for the large aeronautical hangars at Orly (¹). With a construction of this

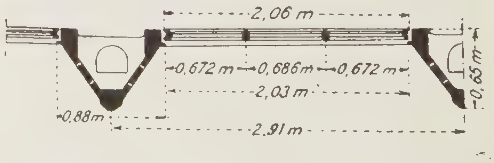

Fig. 5. — Part horizontal section of the outer wall.

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(¹) See the description of the dirigible hangars at Orly in the *Génie Civil* for the 22nd and 29th September and 6th October 1923.

kind it is necessary to have as low as possible a value for the ratio between the section and the moment of inertia. This condition is easily obtained by means of rolled I and U sections; it has not often been used up to the present in reinforced concrete buildings, and has never been used with masonry structures.

A comparison was made between the quantities of material required to build the outside wall of the roundhouse in the usual way with posts, transoms, longitudinals and other elements, and this new method using V section posts. This comparison showed that the saving in materials with this latter method is 70 % in the case of the concrete and 57 % in the case of the steel needed. In addition it must not be forgotten that the cost price of these materials is considerably lower for ouside walls consisting of V sections which can be prefabricated, so that the moulds can be used again and again, and the parts hoisted into position, which reduces the amount of scaffolding and shuttering required.

Investigations were made into the cost of the outer wall according to the distance between the pillars, and an equation prepared for the costs of the different factors concerned, namely :

Concrete and steel, used for each element : piers, transoms, frame, basements;

Capital depreciation on the moulds, labour and handling the moulds, putting the elements into position, capital depreciation on the hoisting gear.

For each of these factors, it is a comparatively easy task to determine the variation in the cost in terms of the dimensions, which depend in turn on the spacing of the main elements. The number of elements required for the outer wall as a whole was taken as the variant, and this determines the distance between the centres of these elements. The functions found for the cost of each factor were fairly simple and can all be reduced to polynomes of small degree or to the formula :

$$(a + bx)\frac{m}{n},$$

in which $m$ and $n$ are positive or negative numbers.

The cost of the outer wall, the sum total of these different functions, was thus easily studied, and the minimum values were looked for when the number of elements varied. This investigation led to 2.65 m. (8′ 8 3/8″) being the optimum distance between centres of the elements. The distance chosen according to all the factors entering into the problem were, as we have said, 2.91 m. (9′ 6 5/8″); so that practically speaking the best arrangement was found.

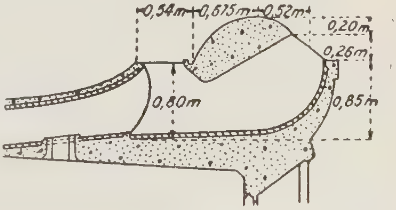

Fig. 6. — Section of the deflector.

*Evacuation of the smoke.* — To make sure that there would be a powerful suction of the smoke, it was necessary to have a permanent zone of depression in one part of the shed. The hoods placed above the locomotive standings (fig. 3) ended in this zone which was sited in the coping of the ouside wall. This arrangement also enabled this wall to be given a standard form, without any horizontal framework, which might have created eddies along the wall. On the contrary the vertical projections were accentuated, which made it possible to guide the currents of gases right into the zone of depression. To make this zone as efficacious as possible, a real static deflector was arranged in the coping, which makes it possible to profit by any wind striking against the wall as well as by those blowing against the roof.

The hoods, made of fibro-cement, are suspended from the roof; their form has been so designed as to speed up the rate at which the smoke ascends and do away with turbulence; they discharge directly into the deflector.

In addition, the inner roof has been fitted with extractor openings (« oculi ») to collect any stray smoke (fig. 4). These openings emerge into radiating ducts forming the ribbing of the roof. These ducts also lead into the circular deflector (fig. 6); in them there is a depression which draws away residual smoke.

The details of the smoke exacuation devices were the subject of tests carried out on models of a roundhouse in the wind tunnel at the University of Paris, at Saint-Cyr. These tests showed the zones of depression very clearly and demonstrated the effects caused by wind blowing directly against the wall and downwards at an angle on the building; diagrams were prepared showing the effects under different hypotheses as regards direction, slope and wind speed. From these tests, it was found that under the best conditions, the deflector was sited in a zone of depression of — 1 to — 1.5 cm (13/32″ to 19/32″) of water (height) and under the worst conditions, in a zone of depression of — 0.46 to — 0.52 cm (1′ 6 1/8″ to 1′ 8 1/2″).

*Lighting.* — In the outer wall, 75 % of the total surface is glazed. The light coming in through this wall meets the requirements for carrying out work on the engines, especially on the side parts, such as greasing and checking the rods.

A detailed study was made by tracing the curves giving the lighting in terms of the dimensions and distance away of the glazed surface at each point of vertical plans radiating inside the shed. This study showed that the optimum height for the wall was about 14 m. (45′ 11″); it showed that it was better not to make the framework of the wall with vertical pillars and horizontal beams or rails. This study therefore led to the outer wall being constructed entirely of vertical parts, to the number of 3 for each element of the roundhouse covering a track; the spacing of the elements of the wall is therefore 2.91 m; this corresponds to the optimum dimensions for the quantity of material used: carrying pillars, transoms, glazed framework, basements and foundations.

Artificial lighting is assured by ordinary lamps; these are sited in the roof; in addition three projectors fitted at the top of concrete masts 12 m. (39′ 4 1/2″) high light the central portion of the roundhouse, and in particular the turntable.

### Avignon shed roundhouse.

The Avignon roundhouse, the first to be built according to the principles we have given above, is 107.50 m. (352′ 9 5/16″) in outside diameter and 14 m. high (fig. 1 to 4); it consists of 36 radiating tracks around a turntable 24 m. (78′ 9″) long. The framework was constructed as we have stated, and the arrangement of the carrying piers so ordered that it was possible to do away with any pillar at the end of a track to give an additional entrance between two adjacent pillars.

The roof is carried on two circles of pillars, an outer and an inner $P_3$ and $P_1$, and an intermediate circle $P_2$ (fig. 2). A fourth circle of pillars between $P_2$ and $P_3$ carries the rollers of the travelling crane; this only runs round three quarters of the circumference.

The different parts of the Avignon roundhouse were completed in three different ways.

The foundations, the pits, the interior pillars $P_1$ and the intermediate pillars $P_2$ were built according to the classical methods; certain pillars were based on Franki piers; the posts were built up by using the ordinary type of forms.

The torus and conical arches of the roof and the corresponding beams were run off in moveable forms carried on trucks (fig. 7), which were used in turn for the different sections of the building.

These forms were moved on at a rate corresponding to 18 m. (59′ 5/8″) of the outer wall every twelve days.

Finally the outer piers $P_3$, the transoms, cornices, supports, basements and glazed framework were prefabricated and hoisted into position, without any concreting being done afterwards.

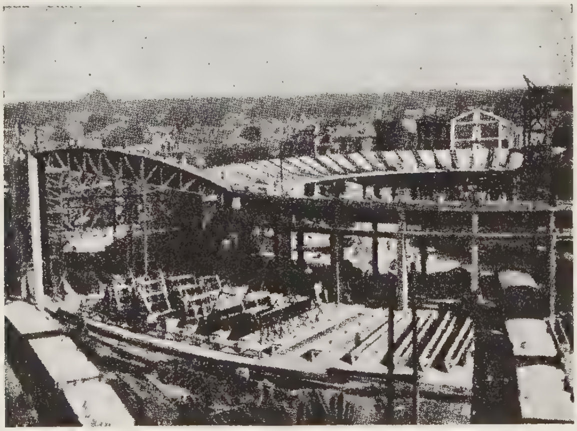

Fig. 7. — View taken whilst the roof was being cast.

The $P_3$ pillars which weigh 8 t. were put into position by raising the piers, placed horizontally and suspended at their centre of gravity by means of a block and tackle. When the required height was reached, the pillar was turned over and directed vertically to its site (fig. 8). This operation took about two hours for each pillar. The putting into position of the supplementary elements of the wall; transoms, cornice, supports, concrete framework and basements was done with the same gear, but much more easily, as the heaviest of these parts did not weigh more than 1.5 t.

The quantity of material used was 2 800 m³ (3 662 cu. yards) of concrete, 280 t. of steel and 4 200 m² (5 023 sq. yards) of glazed framework.

## Conclusion.

The method of construction adopted for the new locomotive sheds has further economic advantages. The careful way in which prefabrication is carried out results in a sufficiently smooth surface which need not be rendered. On the other hand, in order to reduce to the minimum the cost of the supplementary work, very thorough investigations were carried out into the building, which made it possible to fit the prefabricated elements with the fittings for water drain pipes, holes for fixing the water, compressed air and steam systems, and the brackets for the lighting and other equipment. This did away with the expense of drilling and fastening after erection by means of scaffolding and ladders, which is still the current practice in the shops.

Thanks to these arrangements, the special constructional methods adopted, and the very simple conception of the buildings, construction was effected very rapidly. In

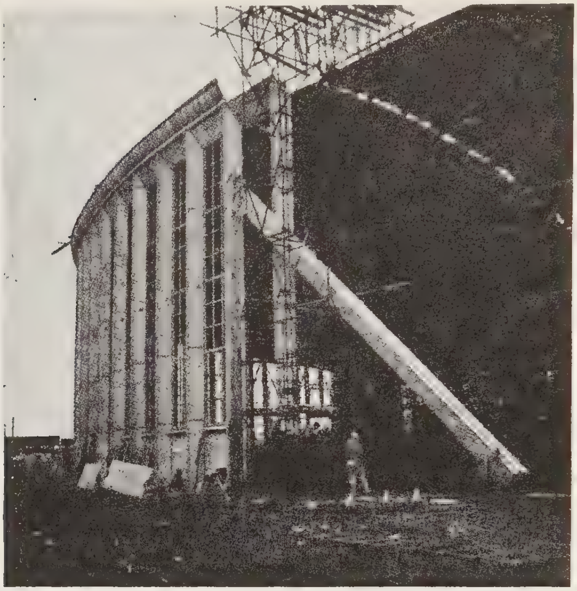

Fig. 8. — View taken whilst an outer wall pillar was being raised into position.

spite of the difficulty of obtaining the necessary materials, the time taken for the work was less than eleven months, though it was expected to take a year.

Roundhouses of this type are being built at Bethune, Cambrai, Creil, Fives-Lille, Hirson, Longueau, Mantes, Metz, Noisy-le-Sec, Poitiers, Somain and Valenciennes. The Longueau roundhouse, which has just been completed, is only semi-circular, but an adjacent section is being built.

[ 385. (06 .111 ]

# OFFICIAL INFORMATION

ISSUED BY THE

## Permanent Commission of the International Railway Congress Association,

19, rue du Beau-Site, BRUSSELS.

XVth SESSION — ROME (1950)

# LIST OF QUESTIONS

for discussion

WITH THE NAMES OF THE REPORTERS.

## 1st SECTION : WAY AND WORKS.

### QUESTION I.

**Modern tendencies in the building of railway structures, especially bridges. Results obtained in the construction of railway bridges in reinforced concrete. Future prospects of the pre-stressed concrete.**

*Reporters :*

*Belgium and Colony, Luxemburg, Netherlands and Colonies, Norway, Denmark, Switzerland, France and Colonies, Poland and Syria :*

Mr. Marguerat, Chef de la Section des Ponts à la Direction Générale des Chemins de fer fédéraux suisses; Berne.

*Italy, Spain, Portugal and Colonies, Bulgaria, Sweden, Turkey, Greece, Czechoslovakia, Jugoslavia, Finland, Hungary and Austria :*

Mr. l'Ing. Prof. Giovanni Polsoni, Inspecteur en Chef supérieur au Service des Travaux et des Constructions de la Direction Générale des Chemins de fer de l'Etat italien; Rome.

*Great Britain and North Ireland, Dominions, Protectorates and Colonies, America (North and South), China, Burma, Egypt, India, Pakistan, Malay States, Iraq and Iran :*

Mr. A. Dean, Chief Officer, Engineering (Works), The Railway Executive; 222, Marylebone Road, London, N. W. 1.

## QUESTION II.

### Rail-joints : improvements in fishplated joints.

### Use of long welded rails : optimum length in relation to the safety and good conditions of the permanent way.

### Expansion gaps. — Determination of standard allowances.

*Reporters :*

*Belgium and Colony, Luxemburg, Norway, Denmark, Netherlands and Colonies, Switzerland, France and Colonies, Poland and Syria :*

Mr. O. LEDUC, Ingénieur en Chef au Service Technique des Installations fixes de la Société Nationale des Chemins de fer français; 42, rue de Châteaudun, Paris (IX$^{e}$).

*Italy, Spain, Portugal and Colonies, Rumania, Bulgaria, Sweden, Turkey, Greece, Czechoslovakia, Jugoslavia, Finland, Hungary and Austria :*

Mr. l'Ing. Bruno RENDA, Inspecteur en Chef supérieur au Service des Travaux et des Constructions de la Direction Générale des Chemins de fer de l'Etat italien; Rome.

*Great Britain and North Ireland, Dominions, Protectorates and Colonies, America (North and South), China, Burma, Egypt, India, Pakistan, Malay States, Iraq and Iran :*

Mr. P. CROOM-JOHNSON, C. B. E. Chief Engineer, London Transport Executive, 55, Broadway, London, S. W. 1.

## QUESTION III.

### New technical methods adopted for the design and construction of large marshalling yards.

*Lay-out and equipment :*

- **Site and importance of siding groups;**
- **Lay-out of connections at entrance to groups;**
- **Longitudinal and cross sections;**
- **Braking installations (Retarders);**
- **Control of point (switch) operation;**
- **Telecommunications;**
- **Lighting;**
- **Staff buildings, etc.**

*Reporters :*

*France and Colonies, Italy, Luxemburg, Norway, Denmark, Netherlands and Colonies, Switzerland, Poland and Syria :*

Mr. Marchand, Ingénieur en Chef au Service Central du Mouvement de la Société Nationale des Chemins de fer français; 8, rue de Londres, Paris (IX^e^).

*Belgium and Colony, Spain, Portugal and Colony, Rumania, Bulgaria, Sweden, Turkey, Greece, Czechoslovakia, Jugoslavia, Finland, Hungary and Austria :*

Mr. J. Van Rijn, Ingénieur en Chef à la Direction de la Voie de la Société Nationale des Chemins de fer belges; 17, rue de Louvain, Bruxelles.

*Great Britain and North Ireland, Dominions, Protectorates and Colonies, America (North and South), China, Burma, Egypt, India, Pakistan, Malay States, Iraq and Iran :*

Mr. J. I. Campbell, Civil Engineer, Eastern Region, The Railway Executive; King's Cross Station, London, N. 1. and

Mr. J. W. Watkins, Operating Superintendent, London Midland Region, The Railway Executive; Euston Station, London, N. W. 1.

## 2nd SECTION : LOCOMOTIVES AND ROLLING STOCK.

### QUESTION IV.

**The comfort of passengers in coaches, railcars and electric motor coaches ;**

- **Sound proofing;**
- **Lighting;**
- **Heating, air conditioning, ventilation, thermic isolation;**
- **Upholstery;**
- **Running stability (type of bogie and suspension).**

*Reporters :*

*Belgium and Colony, Luxemburg, Norway, Denmark, Netherlands and Colonies, Switzerland, France and Colonies, Poland and Syria :*

Mr. O. G. Weberg, Ingénieur en Chef à la Direction Générale des Chemins de fer de l'Etat danois; 40, Sölvgade, Copenhague.

*Italy, Portugal and Colonies, Rumania, Bulgaria, Sweden, Turkey, Greece, Czechoslovakia, Jugoslavia, Finland, Hungary and Austria :*

Mr. l'Ing. Mario MARTINELLI, Inspecteur principal au Service du Matériel et de la Traction des Chemins de fer de l'Etat italien; Florence.

*Great Britain and North Ireland, Dominions, Protectorates and Colonies, America (North and South), China, Burma, Egypt, India, Pakistan, Malay States, Iraq and Iran :*

Mr. N...

## QUESTION V.

**Improvements in the construction of rolling stock (motor and trailer) in view of increasing the mileage between repairs :**

- **Solid wheels or with tyres (metal used for the tyres and solid wheels, behaviour in service);**
- **Axle boxes;**
- **Wearing and friction metals;**
- **Springs (qualities, shape, manufacture).**

*Reporters :*

*Belgium and Colony, Luxemburg, Norway, Denmark, Netherlands and Colonies, Switzerland, France and Colonies, Poland and Syria :*

Mr. CHAN, Ingénieur en Chef au Service Technique du Matériel et de la Traction, Chef de la division des Etudes de Locomotives à vapeur à la Société Nationale des Chemins de fer français; 20, Boulevard Diderot, Paris (XII^e^).

*Italy, Spain, Portugal and Colonies, Rumania, Bulgaria, Sweden, Turkey, Greece, Czechoslovakia, Jugoslavia, Finland, Hungary and Austria :*

Mr. l'Ing. A. D'ARBELA, Inspecteur en Chef au Service du Matériel et de la Traction des Chemins de fer de l'Etat italien; Florence, and

Mr. l'Ing. Mario FASOLI, Inspecteur en Chef au Service du Matériel et de la Traction des Chemins de fer de l'Etat italien; Florence.

*Great Britain and North Ireland, Dominions, Protectorates and Colonies, America (Nort and South), China, Burma, Egypt, India, Pakistan, Malay States, Iraq and Iran*

Mr. E. PUGSON, Chief Officer (Carriage and Wagon Construction and Maintenance) The Railway Executive; 222, Marylebone Road, London, N. W. 1.

## QUESTION VI.

**Comparative study of the different types of transmission between motors and axles of electric locomotives, electric motor coaches and Diesel-electric railcars.**

**Effect on the track of the types of bogies and systems of motor suspension.**

*Reporters :*

*Belgium and Colony, Luxemburg, Norway, Denmark, Netherlands and Colonies, Switzerland, France and Colonies, Poland and Syria :*

Mr. Hoffet, Chef de Section à la Division de la Traction et des Ateliers de la Direction Générale des Chemins de fer fédéraux suisses; Berne.

*Italy, Spain, Portugal and Colonies, Rumania, Bulgaria, Sweden, Turkey, Greece, Czechoslovakia, Jugoslavia, Finland, Hungary and Austria :*

Mr. Javier Tapia, Ingénieur en Chef au Service de la Traction électrique de la Red Nacional de los Ferrocarriles Españoles; Madrid.

*Great Britain and North Ireland, Dominions, Protectorates and Colonies, America (North and South), China, Burma, Egypt, India, Pakistan, Malay States, Iraq and Iran :*

Mr. W. S. Graff-Baker, B. Sc., Chief Mechanical Engineer (Railways), London Transport Executive; 55, Broadway, London, S. W. 1.

## 3rd SECTION : WORKING.

## QUESTION VII.

**Organizing methods to be used in large marshalling yards and terminals, to reduce to the minimum the cost per wagon shunted.**

- **Determination of the staff and number of shunting engines needed;**
- **Capacity and control of the efficiency of the marshalling yards;**
- **Recording and numbertaking arrangements in the arrival and departure yards;**
- **Statistics and traffic analysis by the control-room;**
- **Braking and retarding arrangements;**
- **The formation of trains for departure.**

*Reporters :*

*Belgium and Colony, Luxemburg, Norway, Denmark, Netherlands and Colonies, Switzerland, France and Colonies, Poland and Syria :*

Mr. LAMARQUE, Ingénieur en Chef, Chef de la Division du Mouvement de la Région Nord de la Société Nationale des Chemins de fer français; 18, rue de Dunkerque, Paris (X$^{e}$).

*Italy, Spain, Portugal and Colonies, Rumania, Bulgaria, Sweden, Turkey, Greece, Czechoslovakia, Jugoslavia, Finland, Hungary and Austria :*

Mr. l'Ing. Mario CIRILLO, Inspecteur en Chef supérieur au Service du Mouvement de la Direction Générale des Chemins de fer de l'Etat italien; Rome.

*Great Britain and North Ireland, Dominions, Protectorates and Colonies, America (North and South), China, Burma, Egypt, India, Pakistan, Malay States, Iraq and Iran :*

Mr. E. W. ROSTERN, Operating Superintendent, Eastern & North Eastern Regions, The Railway Executive; Marylebone Station, London, N. W. 1.

## QUESTION VIII.

**In view of the ever increasing weight of road competition, what are the most appropriate measures, apart from reduced rates, for keeping traffic by full wagon loads in the hands of the railway?**

**Would not road transport at the end of the railway journey be justified in order to get direct contact with clients who are not connected up by railway sidings?**

**Should not the road vehicles required to assure such transport be attached to central stations, equipped with suitable handling equipment, from which the road transport services would start?**

**Choice of the vehicles to be used.**

*Reporters :*

*Belgium and Colony, Luxemburg, Norway, Denmark, Netherlands and Colonies, Switzerland, France and Colonies, Poland and Syria :*

Mr. GIRETTE, Chef du Service de l'Exploitation de la Région Sud-Ouest de la Société Nationale des Chemins de fer français; 1, Place Valhubert, Paris (XIII$^{e}$).

*Italy, Spain, Portugal and Colonies, Rumania, Bulgaria, Sweden, Turkey, Greece, Czechoslovakia, Jugoslavia, Finland, Hungary and Austria :*

Mr. Mario Dias Trigo, Ingénieur en Chef de la Section d'Exploitation et Statistique à la Direction Générale des Chemins de fer au Ministère des Communications; Rua S. Mamede (ao Caldas), 21, Lisbonne.

*Great Britain and North Ireland, Dominions, Protectorates and Colonies, America (North and South), China, Burma, Egypt, India, Pakistan, Malay States, Iraq and Iran :*

Mr. N...

## QUESTION IX.

**Modern safety and signal installations (centralising apparatus for block system and signals).**

**Central electric apparatus with individual levers and « all relay » levers (all electric interlocking).**

**Automatic block-system with continuous current and coded current.**

**Light and speed signalling.**

*Belgium and Colony, Luxemburg, Norway, Denmark, Netherlands and Colonies, Switzerland, France and Colonies, Poland and Syria :*

Mr. E. J. F. Derijckere, Directeur de l'Electricité et de la Signalisation de la Société Nationale des Chemins de fer belges; 17, rue de Louvain, Bruxelles.

*Italy, Spain, Portugal and Colonies, Rumania, Bulgaria, Sweden, Turkey, Greece, Czechoslovakia, Jugoslavia, Finland, Hungary and Austria :*

Mr. l'Ing. Rigo Righi, Inspecteur en Chef supérieur au Service des Travaux et des Constructions de la Direction Générale des Chemins de fer de l'Etat italien; Rome.

*Great Britain and North Ireland, Dominions, Protectorates and Colonies, America (North and South), China, Burma, Egypt, India, Pakistan, Malay States, Iraq and Iran :*

Mr. H. H. Dyer, Chief executive officer Engineering (Signals and Communications), The Railway Executive; 222, Marylebone Road, London, N. W. 1.

## 4th SECTION : GENERAL.

### QUESTION X.

**Drawing up the financial balances regarding passenger and goods services taking into account the prime cost of trains : per category, per line and per type of motive power.**

**Principles and methods of calculation.**

*Reporters :*

*France and Colonies, Belgium and Colony, Luxemburg, Netherlands and Colonies, Switzerland, Italy, Spain, Portugal and Colonies Bulgaria, Rumania, Greece, Turkey, Czechoslovakia, Jugoslavia, Hungary, Austria, Poland and Syria :*

Mr. DUGAS, Directeur, Chef du Service Technique de la Direction Générale de la Société Nationale des Chemins de fer français; 88, rue Saint-Lazare, Paris (IX°).

*Great Britain and North Ireland, Dominions, Protectorates and Colonies, America (North and South), Sweden, Norway, Denmark, Finland, China, Burma, Egypt, India, Pakistan, Malay States, Iraq and Iran :*

Mr. Arne SJÖBERG, Chief Research Economist, Swedish State Railways; Stockholm.

### QUESTION XI.

**Organisation and development of medical and social services with partnership of the staff in their management.**

*Reporters :*

*Belgium and Colony, France and Colonies, Luxemburg, Norway, Denmark, Sweden, Finland, Netherlands and Colonies, Switzerland, Italy, Spain, Portugal and Colonies, Bulgaria, Rumania, Greece, Turkey, Czechoslovakia, Jugoslavia, Hungary, Austria, Poland and Syria :*

Mr. Dr. HUYBERECHTS, Directeur Général adjoint de la Société Nationale des Chemins de fer belges; 17, rue de Louvain, Bruxelles.

*Great Britain and North Ireland, Dominions, Protectorates and Colonies, America (North and South), China, Burma, Egypt, India, Pakistan, Malay States, Iraq and Iran :*

Mr. P. H. SARMA, Director of Wagon Interchange and General Secretary of the Indian Railway Conference Association; New Delhi (India).

## QUESTION XII.

**What must the importance and the prevailing conditions of traffic be, in order that from the economic point of view :**

**a) the construction of a railway line;**

**b) the keeping operating an existing railway line;**
**should be useful?**

*Reporters :*

*Italy, Belgium and Colony, France and Colonies, Luxemburg, Norway, Denmark, Sweden, Finland, Netherlands and Colonies, Switzerland, Spain, Portugal and Colonies, Bulgaria, Rumania, Greece, Turkey, Czechoslovakia, Jugoslavia, Hungary, Austria, Poland and Syria :*

Mr. Dr. Prof. Nicola LALONI, Chef du Service Commercial et du Trafic de la Direction Générale des Chemins de fer de l'Etat italien; Rome.

*Great Britain and North Ireland, Dominions, Protectorates and Colonies, America (North and South), China, Burma, Egypt, India, Pakistan, Malay States, Iraq and Iran.*

Mr. Sven BOYE, Inspecteur principal des Chemins de fer de l'Etat norvégien; Oslo.

## 5th SECTION : LIGHT RAILWAYS AND COLONIAL RAILWAYS.

## QUESTION XIII.

**Modernisation of the maintenance methods of the permanent way on the light railways.**

*Reporters :*

*France and Colonies, Belgium and Colony, Luxemburg, Norway, Denmark, Sweden, Finland, Netherlands and Colonies, Switzerland, Italy, Spain, Portugal and Colonies, Bulgaria, Rumania, Greece, Turkey, Czechoslovakia, Jugoslavia, Hungary, Austria, Poland and Syria :*

Mr. RIPERT, Ingénieur en Chef du Service de la Voie et des Travaux de la Société Générale des Chemins de fer Economiques; 4, Cité de Londres, Paris (IX$^{e}$).

*Great Britain and North Ireland, Dominions, Protectorates and Colonies, America (North and South), China, Burma, Egypt, India, Pakistan, Malay States, Iraq and Iran :*

Mr. J. R. FARQUHARSON, Chief Engineer of the East African Railways and Harbours, Nairobi (Kenya).

## QUESTION XIV.

### Change over from steam locomotives traction to Diesel traction.

*Reporters :*

*Italy, Belgium and Colony, France and Colonies, Luxemburg, Norway, Denmark, Sweden, Finland, Netherlands and Colonies, Switzerland, Spain, Portugal and Colonies, Bulgaria, Rumania, Greece, Turkey, Czechoslovakia, Jugoslavia, Hungary, Austria, Poland and Syria :*

Mr. Dr. Ing. Manlio DIEGOLI, Inspecteur en Chef au Service du Matériel et de la Traction des Chemins de fer de l'Etat italien; Florence.

*Great Britain and North Ireland, Dominions, Protectorates and Colonies, America (North and South), China, Burma, Egypt, India, Pakistan, Malay States, Iraq and Iran :*

Mr. A. W. OLIVIER, Ingénieur en Chef au Service de la Traction de la S. A. des Chemins de fer Néerlandais; Utrecht.

## QUESTION XV.

### Signalling on single track lines.

*Reporters :*

*Belgium and Colony, France and Colonies, Luxemburg, Norway, Denmark, Sweden, Finland, Netherlands and Colonies, Switzerland, Italy, Spain, Portugal and Colonies, Bulgaria, Rumania, Greece, Turkey, Czechoslovakia, Jugoslavia, Hungary, Austria, Poland and Syria :*

Mr. VRIELYNCK, Directeur du Service du Matériel de la Société Nationale des Chemins de fer vicinaux (Belgique); 14, rue de la Science, Bruxelles, and

Mr. THOMAS, Ingénieur au Service du Matériel de la Société Nationale des Chemins de fer vicinaux (Belgique); 14, rue de la Science, Bruxelles.

*Great Britain and North Ireland, Dominions, Protectorates and Colonies, America (North and South), China, Burma, Egypt, India, Pakistan, Malay States, Iraq and Iran :*

Mr. H. W. JACKSON, M. Sc. Eng., Chief Signal Engineer, South African Railways and Harbours; Johannesburg.

# NEW BOOKS AND PUBLICATIONS.

(625 .28 (44) )

**Locomotives des Chemins de fer francais, à vapeur, électriques, Diesel-électriques et autorails.** — *(The Locomotives of the French Railways, steam, electric, Diesel-electric and railcars).* — No. 2, October 1948. Preface by M. Paul LEGREGEOIS, Inspecteur divisionnaire à la Division des Etudes des Locomotives à vapeur de la S. N. C. F. — One album (6 × 9 1/2 inches) of 72 pages, diagr. and photogr. — 1948, Paris, Editions P. P. C., 39, boulevard Berthier. (Price : 385 French fr.).

The choice of traction stock in this second volume is more varied than in the first (see *Bulletin* for July 1949). The author appears to have had two preoccupations : on the one hand principally in the case of steam locomotives to add a few types intended to show their evolution since the beginnings; on the other, with both the steam locomotives and others, stress those which meet the characteristic needs of the operation and those which endeavour to profit by the new technical resources available.

Amongst the 12 steam locomotives whose characteristics are given, the first 8 belong to the « historic » group. From 4 driving pairs of wheel and a 5 $m^2$ grate with a working pressure of 20 kgr. we go back to the single driver of Crampton Stephenson and Buddicom. The latter has a 0.9 $m^2$ grate and a working pressure of 8.5 kgr./$cm^2$. The other 4 include a *Santa Fe* with booster, a 4.6.4 with small individual equal current double acting engines, a 4.6.4 with turbines (without condenser) and a 4.6.0 with Velox boiler using liquid fuels.

Of the 8 electric locomotives and railcars given, two are recent prototypes, the CC-6000 of 1946 and the BB-8000 of 1947, both for mixed services in the South-Western Region. The first raised the record adhesive weight to 120 000 kgr. (264 550 lbs) and has a power of 3.600 H.P. During trials it hauled 800 tons on the level at 100 km./h. (62 m.p.h.) and 1 200 tons at 45 km./h. (27 m.p.h.) on gradients of 10. All these locomotives are gear driven.

The 3 electric railcars were built in 1947, 1938 and 1927. That of 1947, the series 4700 of the South West Region, can run at 140 km./h. (86 m.p.h.). Its total weight is 79 000 kgr. (174 165 lbs) with a power of 1 000 H.P. and it can carry 110 passengers : 24 second class and 86 3rd class.

The Diesel-electric locomotives are represented by two shunting engines with a single engine and a relatively low power, and by a very powerful locomotive. This is noteworthy on account of its power (3 100 H.P.), its maximum speed (130 km./h. = 80 m.p.h.), its total weight (223 000 kgr. = 491 640 lbs) and its great length (32.70 m. = $107'3^{1}/_{2}''$). It is of the 262 type (two identical elements). In addition to the 4 Diesel engines with 6 cylinders in line, its equipment includes 4 generators and 6 double induction engines. It was built to haul 600 ton trains at a maximum speed of 130 km./h. between Paris and Mentone.

The designs of the railcars are widely different. There are 5 Diesel types, all 4 stroke, and 1 internal combustion engine. Mechanical drive is the most usual, being found on 4 compared with electric drive on 2. The power varies between twice 160 and twice 300 H.P. The mechanical drives differ as the clutch may be by discs, hydraulic pressure, or a cone with oil pressure and the gear box which may have synchronised gears, constant gears or an electro-magnetic device. The speed record is held by the Bugatti railcars (140 km./h. = 87 m.p.h.) which also have the lowest weight on the most heavily loaded pair of wheels (6 000 kgr. = 13 280 lbs). The double Renault railcar has the greatest seating capacity (40 2nd class and 71 3rd class). In running order this weighs 72 000 kgr. (158 740 lbs) i.e. 649 kgr. (1 430 lbs) per seat.

One interesting feature is found on the *Alsthom* railcars with Diesel engines and electric drive. A pantograph makes it possible to feed the traction motors directly from the overhead wires. These railcars can therefore run over the electrified lines without using the Diesel engines and generators.

Two illustrations, one a drawing and one a photograph show a locomotive on the Vitry testing plant where all the prototype steam locomotives are put on trial.

E. M.

[ **656** .237 (494) ]

WERZ (Willy F.). Doctor of Economics, Economist attached to the Swiss Federal Transport Office. — **La Comptabilité des Chemins de fer privés suisses.** *(The accounts of the private Swiss Railways).* — One volume (6 × 9 in.) of 308 pages. — 1948, Berne, Stampfli & Cy, Publishers.

The title of this book, although well adapted to the subject matter, may give the reader an impression that the field covered is somewhat limited. It must be remembered that in Switzerland, before the law buying up and creating the Swiss Federal Railways was passed, there were none but private railways, and consequently the whole railway system is concerned. Even the Swiss Federal Railways, as will be seen in Chapter X, are still affected by these regulations to some extent, taking into account the clauses of the law taking them over, and measures subsequently decided upon.

The first law regarding railway accounts dates from 1883. Before this time the intervention of the State in these was based first of all on the law of 1852 and then on that of 1872, both entitled « law on the establishment and operation of railways ». In an historical introduction, the author analyses the clauses of these two laws in so far as they come within the framework of his subject, together with the use made of them and the clauses contained in the decrees of concession. The taking over clauses are the most important ones in this case.

With the law of 1883, the powers of the authorities were defined and extended. The author indicates the circumstances which gave rise to it, and whilst giving the mechanism of this new instrument, he gives an interesting report of its application and effects. Its great defect was the lack of precision concerning the factors determining the net yield. The importance of this will be understood when it is remembered that the idea of taking the railways over was already in the air.

The law of 1896, which is still in force at the time of publication, was intended to correct the defects of the previous law. Whilst laying down general prescriptions concerning the keeping of the Companies' accounts, it was above all, as Dr. WERZ explains, paving the way for taking over the railways. Promulgated a short time before the date (1st May 1898) when the Confederation had to decide whether or not to ratify the proposed purchase, in spite of its special character it was the object of very lively opposition. It was however passed by popular vote with a large majority (4th October 1896).

Such are the origins of the legislation now in force which the author has drawn in outline. He then makes a complete and methodical study of the subject. He examines in turn the supervisory rights of the Confederation, the construction account, the sinking fund account, the operating account, the profit and loss account, the balance sheet, and the capital account. Each of these chapters has its own special interest. The reader will appreciate in particular the discussion on the discrimination between the expenditure to be booked to the construction account and that to the sinking fund account. The latter includes a report of the various ideas concerning the renewal funds and a detailed study of the working of this fund.

The aspects under which these questions are considered are very numerous. We will only mention the fact that one of the objects of the law was to protect the interests of the Confederation and the public. This is the justification of the chapter concerning the net yield, the definition of which can vary a lot as it can be based on two different ideas according to the point of view considered, calculating the cost of taking over or lowering the cost of transport.

As regards the verification and approval of the accounts, the author explains how the controls work, discusses their effectiveness and indicates the measures which could be taken under the present law whilst awaiting its revision.

A new revision of the law on the Railway accounts is in fact in preparation. The author indicates the points which he considers should be dealt with, together with his reasons; they are many. Until such time as a new law has been passed, a new ordonnance of execution has been prepared. The text is given in the appendix, following that of the present law.

This short review only gives a very incomplete idea of the book. The events the author places before us in his review of these happenings show us the importance of the question, and how it has led to serious controversy in Switzerland, and to very thorough investigations. These have no doubt been due to the abundant and widespread nature of the lines and the diversity of interests concerned.

In Dr. WERZ's book, the specialists will have the satisfaction of finding practical information side by side with the theoretical review. It will occupy a high place in railway literature which is very scanty as regards this subject.

E. M.

[ **385**. (06.1 (7+8) ]

**V Congreso Panamericano de Ferrocarriles.** *(Reports of the Fifth Pan-American Railway Congress)*. — Montevideo. — April 1946. — 5 volumes (6 3/4 × 9 1/4 in.), in all about 2000 pages, illustrated. — 1947, Montevideo, Tallerse de « La Industrial Grafico Uruguaya », Cerrito, 740.

The Pan-American Railway Congress, which was held in Montevideo in April 1946, is interesting from several points of view. First of all, it is of value to see how it was organised and compare it with the Congresses held by our Association. And then the reports presented and the approval given them may include some valuable information.

The continuity of the Congress depends on the existence of a permanent Association represented by a Permanent Commission and an Executive Committee. The statutes of the Association are given in Volume I of the Reports of the Montevideo Session. The Governments of the States, public and private railways, public administrations and persons having civil and legal interests whose activities are helpful to the institution are all eligible for membership. There are four categories of members, and the subscriptions vary according to the category and also according to the length of the lines in operation.

Membership of the Association may be for one given Congress, but there are also life members. These pay a single subscription of 50 American dollars. The rights of members differ according to their category.

In addition to the Permanent Commission and Executive Committee, there is a National Commission in each country consisting of ten members appointed at the end of each Session of the Congress.

Sessions are normally held every four years. The time and place of the next Session is decided at the end of a Session subject to the agreement of the Government of the country in question, and if necessary the Permanent Commission can modify the arrangements made in agreement with the Government concerned.

All the proceedings of the Montevideo Congress were invested with great solemnity. The opening session and closing session took place in the Meeting Hall of the Chamber of Representatives in the presence of the highest authorities of the country and the diplomatic corps.

The President of the Eastern Republic of Uruguay, the Minister of Public Works and the President of the Permanent Commission were Honorary Presidents of the Congress. The working President was the General Manager of the Uruguay Railways. The Presidents of the Nations, who sent delegates, were also Honorary Presidents.

In conformity with a clause in the Statutes, the composition of the local Management Committee was fixed by the Government in a decree issued by the President of the Republic, which laid down the time and place of the Congress. The presidency was entrusted to the Minister of Public Works.

In addition to the delegates of the South American Republics, the Congress also numbered amongst its delegates members from Mexico and the United States of America.

The work of the Congress was divided into six sections, viz: Way and Works, Rolling Stock and Traction, Operation, Accounts and Statistics, Legislation and Administration, and General Questions.

The programme of the Congress included a total of 33 subjects to be discussed. The Organisation Committee received 116 communications. These were classified into simple communications, reports of various applications and the results obtained, and theses requiring summaries to be drawn therefrom. The reports presented were by authors from different countries, who were members of the Association. There were reports prepared by groups or authors from North America, such as Mexico and the United States. The participation of these countries justified the name of Pan-American applied to the Congress for the first time at this Montevideo Session.

Amongst the questions presented for discussion, the most numerous by far dealt with subjects of topical interest on account of improvements in technique and new organisation ideas. As we have no room to quote them all, we will give a few examples from the different sections: the modernisation of the permanent way necessitated by high speeds and heavy axle loads, technical and economic investigation into the different systems and new methods of traction, the use of light, fast railcars, standardisation of the accounts and statistics, and calculation of the cost of the different systems of transport, modernisation of railway legislation in order to give the rates greater flexibility and simplify the regulations.

The co-ordination of transport received a great deal of attention both in the official speeches and in the discussions. The Organisation Committee received at least six communications concerning this subject. Unlike the other questions for which the summaries presented to the Plenary Meeting were in general fairly concise and often little discussed, those formulated by the section dealing with the co-ordination of transport were developed at length. They gave rise to lengthy exchanges of opinions during the two Plenary Meetings. Amongst the measures suggested in addition to legal and governmental intervention, mention must be made of those advocating giving wide publicity to the reports and works of the Congress, and keeping the matter closely before the representative organs of the Association. In each country the National Commission will appoint one of its members to maintain contact with the Permanent Commission, and keep it informed of the current evolution of the question. The necessary steps will be taken to see that it is maintained on the agenda of the next Session.

Another question dealt with the competition of the different methods of transport. This was an investigation into the rating systems most in line with public interest in view of competition.

Reading the summaries of these proceedings shows the great importance attached, and with reason, to transport in general and the railway in particular on the other side of the Atlantic.

E. M.

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[ **625** .144 .2 ]

LAMALLE (Ulysse), Ingénieur Civil des Mines A. I. Lg., Honorary General Manager of the Belgian National Railways, Professor at the University of Louvain. — **Cours d'exploitation des Chemins de fer.** *Tome III* : *La voie.* — *Fascicule II* : **Pose de la voie en courbe** (3^e^ édition). *(Railway Operation. Volume III : The Permanent Way. Part II. Laying track on curves).* 3rd Edition. — One brochure ($7\,^7/_8 \times 10\,^1/_4$ inches) of 56 pages with 42 figures, 1949, Louvain, Librairie Universitaire Ch. Uystpruyst, éditeur, 10, rue de la Monnaie, and Paris, Dunod, éditeur, 92, rue Bonaparte.

The laying of track on curves which has long received a great deal of attention from railway engineers has become a matter of greater importance as the speeds have increased. Although 120 km. (74 miles)/h. is the speed limit allowed on many railways, this is often exceeded nowadays. In Belgium, before the war, there were already some trains running at 140 km. (87 miles)/h. This speed will be the recognised maximum speed on the main arteries of the French Railways, whilst still higher speeds are under consideration in certain cases.

As the track and rolling stock had to stand up to the increased stresses, the rules concerning the superelevation, which is intended to make good the centrifugal forces and is the most striking characteristic of track laid on curves, had to be revised.

The author gives a thorough explanation of the classical formula for calculating the superelevation to obtain perfect equilibrium at a given speed. But as everyone knows the question is not completely solved by this.

Various circumstances make it difficult to choose the speed on which the formula is to be based, and it is often impossible to obtain the theoretical cant. All considerations to take into account are studied and each one has its influence measured.

As regards insufficient superelevation, the discussions deal mainly with the arguments regarding safety and comfort. Examples of the regulations enforced by various railways show that there is some divergence of opinion regarding the allowable non-compensated centrifugal force.

Apart from the difficulty of deciding this quantity, there is also the way in which it is to be expressed in practice, using the homogenous formula $\frac{a}{g} = \frac{h}{e}$. The author comments on the influence of such values as 0.40 and 0.60 for the free acceleration $a$ or values such as 0.60 and 0.90 for insufficient superelevation $h$. From this he deducts the formula for the maximum allowable speed.

Regarding the question of parabolic transitions between the straight and circular curves, the theoretical part includes a report of the methods applicable in the case of a new line and when a curve has to be improved. This is followed by a very useful supplement giving the instructions and numerical tables available for the men carrying out the work.

One remark made regarding the importance from the point of view of comfort of the speed of the variation in the non-compensated acceleration should be stressed. Calculations show that when running over the transition curve, the proportionality of the superelevation to the curvature affects the progression of the acceleration, which prevents passengers from feeling any disagreeable sensations.

The other characteristics of laying track on curves, the greater width between rails and the use of short rails, are dealt with in the same way, the theoretical ideas being supported by figures of immediate practical use.

Finally, mention may also be made of a passage dealing with the connections of slopes and gradients, a question of equal importance on lines run over at speed. They can be connected either by a circular curve or a parabola of the second degree. The properties of the latter give a convenient method of layout.

E. M.

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[ **656** .256 .3 (492) ]

VERSTEGEN (Eng. J. H.). **Automatisch blokstelsel op de Nederlandsche spoorwegen.** *(The automatic block on the Netherlands Railways)*. — One volume (5 1/2 + 7 7/8 in.) of 234 pages, with 57 figures and numerous plates. — 1948, Utrecht, published by N. V. Nederlandsche Spoorwegen.

The automatic block has not yet been extensively applied in Europe, apart from Metropolitan Railways. But the programmes now being carried out show that it will be considerably extended in the next few years. In France and Italy in particular, all the main lines are to be equipped with automatic light signals. M. VERSTEGEN's book is therefore very topical.

The book is also very interesting on account of the wide experience of the Netherlands Railways in this special technique. The diversity of the installations described have led to fruitful investigations. The first application was made in 1926 on a section of line covering 4 blocks in each direction. At the present time, 9 sections are equipped in this way, amounting to 100 km. (62 miles) of double track line. Semaphore signals are used on 7 of them, the two others have light signals. They are all electrified lines now.

Amongst the principles discussed to begin with, mention must be made of the question whether the signals are normally to stand at danger or at line clear, and that of the division of the block sections in order to shorten the track circuits. In the case of steam traction, there is freedom of choice between alternative current and direct current for the track circuits. The author explains why A. C. is better (with relays with two windings) as well as the reasons which led the Netherlands Railways to adopt D. C. on lines then operated by steam.

To describe the D. C. installations and

semaphore signals, the author makes use of plates giving detailed diagrams of the electric circuits. He deals in turn with batteries, relays, and the equipment for working the signals. Special attention is devoted to the relay which is the core of the automatic block. The necessary conditions for opening and closing the circuits with certainty are given by means of equations giving the value of the current in the rails and relays under various circumstances. To repeat the signals, use is made of a separate warning worked by a polarised relay cutting out the wires between the two signals.

A margin of safety is provided between the signal and the terminal point of the section. This is obtained by special arrangements required for safety.

Statistics of the breakdowns considered in themselves and compared with those in other countries show that the installations are working very satisfactorily. This result is attributed amongst other things to very well organised and careful maintenance.

On three sections, the Netherlands Railways have changed over from steam to electric traction. The author gives the principles of the steps taken and describes the installations. It was found more opportune to retain the semaphore signals. At each end of the section inductive connections allow the traction current to pass but cut out the signalling current which is alternating. Diagrams of the electrical equipment are given for both cases : with or without line wiring.

Finally, two other sections were already electrified when equipped with the automatic block, and these profited by the most up-to-date equipment including light signalling. Here again we are given complete diagrams of the electric circuits. There is only one lamp per signal, the changes of colour being obtained by coloured lenses fixed in a binocular mounting. There are no three position signals properly speaking, but only when required the superposition of the stop and warning signals.

Many electric circuits are shown diagrammatically in the plates together with installation plans of the chief equipment.

A supplementary chapter gives the connecting up regulations and details about the relays, dry pile batteries, light signals, inductive connections, and precise maintenance regulations. It will certainly be of interest to those responsible for the proper working of automatic signalling equipment.

E. M.